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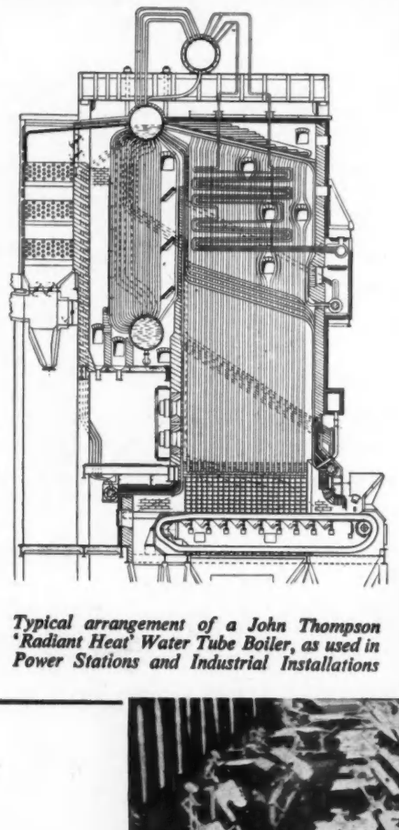

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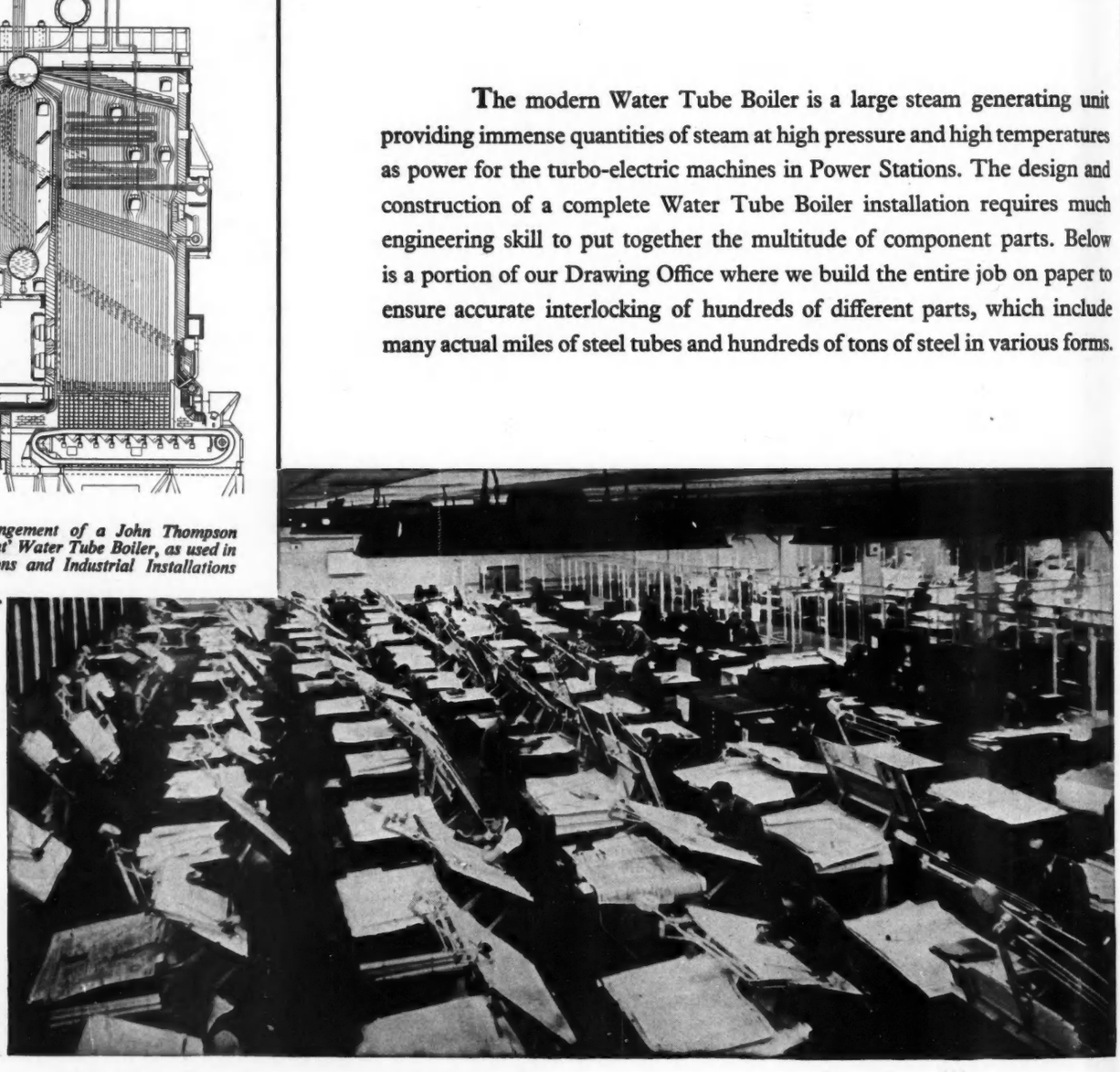

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Vol. 179 No. 4652 MARCH 25, 1955

Leading Article
Window on the World 357

Weekly Survey
Green or Amber for Cars? 358
Select Committee on Nationalised Industries 358
Stabilising Lake Nyasa 358
Opening-Up East Africa 358
Comets for B.O.A.C. 359
American Gas Turbine to be built in Britain 359
Drop Forgers' Steel 359
Du Pont de Nemours 359
Power in the Wind 359

Principal Articles
The Education of the Chemical Engineer: International Discussion of Training Methods 360
Hand-Wrought Chains: A Little-Known Industry 364
The Engineering Outlook—11. Motor Vehicles: An Expansion in Output of Low-Price Cars? 367
Direct-Current Testing of Stator Windings 369
Remote Control: Manual and Automatic Systems 370
Wind-Generated Electricity: Prototype 100-kW Plant 371
Detecting Leaks in Buried Pipelines 375
Structural Safety of Aircraft: Statistical and Probability Concepts 376
Two-Way Control Valve for Bulk Material Handling 377
Size Distribution in Fine Powders: Analyser Based on Stokes' Law 378
Horizontal Engine for Rail Traction: Underfloor Units of 300 and 450 b.h.p. 379
High-Pressure Flexible Tubing 380
Measuring and Inspection: New Gauge Room at the Works of Alfred Herbert Limited 380
Electrical Engineers Exhibition 381
Special Trains for Laying Cables through Tunnel: New Communication Lines under the Severn 382
De-Burring Machine: Gears Cleaned by Rotating Wire Brushes 383
Record Storage: Underground Depository 383
Running Diesel Engines on Boiler Oil: Corrosion-Resistant Valves Needed 384
Heavy-Duty Tipping Gear for Vehicles: High-Speed Action 384
Portable Gas Turbine 385

Letters to the Editor
Low-Friction Fluid Seals: The Quip Modest 361
Weighing the Output of a Colliery 361

Obituary
Engineer Captain Edgar C. Smith, O.B.E. 362

Book Reviews
Irrigation and Hydraulic Design. Vol. I: General Principles of Hydraulic Design 365
Radio and Television Engineers' Reference Book 365
The Recruitment and Training of Men Intended for Management Positions 365

News
Electricity Supply Tariffs 361
Electricity Supply in February 361
The Whitworth Society 362
The Royal Society: Annual Election of Fellows 364
I.Mech.E. Council Elections 364
Dual-Trace Oscilloscope 369
Preventing Thread Seizure 374
Testing Grit Arresters 377
Bitumen-Protected Metal Roofing Sheets 379
Town Gas from Petroleum 385
Kotri Barrage Opened 385

Personal 363, Commercial 363, Contracts 363, Books Received 366, Trade Publications 367, British Standards 367, Launches and Trial Trips 380, Forthcoming Exhibitions and Conferences 386, Labour Notes 387, Notices of Meetings 388

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WINDOW ON THE WORLD

FILM is a force. It is an argument, an appeal, an explanation. At one extreme—a brash side-show; at the other—a poem. More than 50 years ago the cinema first took its place in the world of entertainment; later, with the advent of documentary film it became a source of information and exhortation. It has long been recognised as an effective medium for publicity. How best can industrial firms be served by such an instrument?

Certainly it can help the manufacturer to advertise his wares. It can draw attention to new products and their virtues; to a potential customer it can reveal his requirements, and how best they may be met; it can persuade and convince; it can be the means of circulating information. With its aid, industry can be brought before the public eye, as with the Rank Organisation series "This Modern Age." Made with a similar purpose but on a smaller scale is the Babcock and Wilcox film bulletin "Home and Away"—the first issue of a quarterly house "magazine" featuring company events, activities and personalities.

From providing information to giving instruction is a small step; the film can be an admirable teacher. It can repeat the perfect lesson perfectly, and with its qualities of sound and motion it offers the ideal visual aid. Sometimes a film may supplement a lecture, sometimes it can be used alone. The British Iron and Steel Federation, for example, emphasise that their series of films on steelmaking is intended for use in conjunction with other classroom work, the lecturer subsequently enlarging on what has been seen. But it is not only craftsmen who can be helped: directors, managers and industrial engineers are sought as an audience for a new Electrical Development Association film entitled "Planned for the Purpose." Its subject is production aids and methods, and its aim to indicate the way in which productivity can be raised by planning.

Whether primarily for teaching or for publicity, for entertainment or pleading a cause, a film has greater power if it combines several approaches. What fails to entertain seldom instructs, and that which neither entertains nor informs will hardly succeed as publicity. The indirect approach is often the more successful. "Modern Meter Manufacture," for instance, is principally concerned with Ferranti instruments, but because it tells too about up-to-date production methods it will interest a wider audience. To seize the interest of an audience is the first aim of every film, and film is a medium with special scope for doing so. With the finest productions the first few minutes, even seconds, of screening convey a conviction of the excellence that is to follow. Commentary and visual image are inseparably linked and accurately synchronised, and character and quality remain unaltered no matter how many times a film is re-run. A blackboard illustration, a wall chart and a technical drawing are necessarily static; animated drawings such as those employed in the Laycock Engineering film "Overdrive" can make lucid even the most complex technical operation. Film can show what cannot normally be seen: slow-motion, close-up and microscopic views are some of its methods. These techniques are particularly well illustrated in the British Oxygen Company's colour film "The Argonaut Welding Process," in which droplet metal transfer is vividly depicted. Heat and brightness would in general prevent observation of this action.

A valuable feature of film is its flexibility, its facility for cutting, arrangement and montage. What is irrelevant or inessential can be excluded; what is selected can be arranged in the most suitable manner. The "live" television camera cannot equal the ciné camera in this respect; if programmes on natural life were televised directly viewers would soon become impatient. The finished film is designed to suit the common denominator of the intended audience; but thereafter it is virtually unalterable. Unlike the reader of the printed word, who can be selective, the viewer must take all or nothing. And, by some means, he must be induced to sit and watch. Therefore, an industrial film will only succeed in its purpose if it is the result of expert and imaginative work; if there has been hard-won understanding between the film-makers and the directors or engineers of the firm. Too often one has seen a film which is a reasonably faithful record of, say, the processes of production, but it lacks any compelling power: there seems to be no special reason why the film should be seen. In all probability it was first mooted by someone who, aware of the power of a good film, jumped hastily from that to the decision to go ahead. It is far better to study the scope and limitations of the medium, and the possibilities of the subject which is to be presented, and then decide whether the two aspects can be combined. Film-making may not be one of the arts (if only because its techniques are far more involved and overlaid with mechanical paraphernalia than the paint and clay and stone of the artist) but it requires a near-artistic skill and sympathy, especially to transcend the sometimes intractable material that industrial firms wish to use for publicity purposes.

Weekly Survey

Cover Picture: *While the services of the skilled hand moulder are still required for a good deal of the work produced in the foundry, many moulds, especially for repetition work and where speed is of importance, are now machine made. The cover picture shows a series of sand moulds produced in the automatic "jolt-squeeze" machine visible in the background.*

* * *

GREEN OR AMBER FOR CARS?

An article on page 367 reviews the performance of the motor industry during 1954 and discusses the problems it faces during the anticipated period of rapid growth up to 1960. The implications of the planned expansion of output from one million to 1½ million vehicles—of which cars will account for at least 1·1 million—are so major that they may well warrant the remarks in the article that we are at the beginning of "an era of radical and profound change in the industrial make-up of Britain."

The industry argues that output must increase to permit the use of the most up-to-date methods and thus reduce (in real terms) the cost of cars—usually measured in pence per lb. Much of this increase, however, will have to be sold at home since exports are not expected to exceed 500,000 within five years, an increase of about 35 per cent. on the 1954 figure. Home sales, by absorbing the balance—600,000 cars—will rise by over 60 per cent. To achieve this a capital investment programme of more than £150 million has been planned by manufacturers of vehicles and vehicle components. If to this is added the amount necessitated by an increase in the rate of road construction or improvement, as well as the provision of parking facilities, garages, etc., total investment may rise to £700 million (a figure quoted in a previous article "How Many Motor Vehicles by 1960?" in ENGINEERING, January 28). The anticipated return in terms of foreign exchange at 1954 average values will be £45 million, the present value of exports being approximately £118 million. On the other hand consumption at home will be increased by more than £90 million, all of which will be for pleasure motoring (on the assumption that business demand is fully met at present).

Such a case against expansion is indeed formidable but the issue is far from straightforward. First, it may not be implemented, since the weight of taxation on motoring is such that the industry may be unable to increase its home sales to 600,000 cars. The article points out, however, that the oil companies are having difficulties in disposing of the increasingly large quantities of motor spirit they are forced to produce in order to meet the demand for fuel and Diesel oils. More cars, or more miles per car, will be necessary to permit this important industry to function effectively; to achieve this, changes in price may materialise, either through reductions in taxation or price, or both. Second, the failure to increase output and so lower manufacturing costs by the use of special machinery and automatic processes may result in a loss of ground overseas. Competition from Volkswagen, Renault, Fiat and others is such that the industry cannot afford to stand still. On the other hand, the opportunities for increased sales abroad as well as at home—if substantial production economies can be achieved—are such that exports could be 750,000 cars instead of 500,000. There is little doubt that the elasticity of demand is such that cheaper cars would find a considerable market, although there appears to exist in the industry a strong feeling—voiced by Sir Patrick Hennessy recently—that demand is not for an austerity car and that the best interests of British manufacturers are served by the medium-size "quality" car.

Whatever can be advanced against the plans, the fact remains that the motor vehicle industry is one of the "growth" industries, upon which the burden of earning foreign exchange is falling increasingly, as several of our staple industries are losing ground in overseas markets. Change is always painful and very often wasteful, but little is to be gained and much may be lost by avoiding this type of waste—which at least holds out a hope.

* * *

SELECT COMMITTEE ON NATIONALISED INDUSTRIES

When the present Government came into office they moved in the House of Commons for the appointment of a Select Committee to consider the methods by which the House could be informed of the affairs of the nationalised industries. The committee issued two unanimous reports. The first dealt with Parliamentary questions and made no recommendation for alteration in the current practice whereby the Minister responsible only answered questions on general policy or of general public importance and not on matters of day-to-day administration. The second proposed the setting up of a committee with the duty of examining the reports and accounts and obtaining further information as to the general policy and practice of the industries, with the object of informing Parliament about the aims, activities and problems of the corporations, but not of controlling their work.

The second report received pretty rough handling in the Press and created alarm and despondency among most of the Boards and opposition from the T.U.C. It was debated in the last session, when the Labour Party speakers, with the exception of those members who had been on the committee, spoke against it. The general view of the critics was that any such attempt by Parliament to oversee the affairs of the nationalised industries must make them "civil service minded" and detract from their initiative. To some extent the committee had recognised the difficulties involved in their proposal and they had made no suggestion that the efficiency of the industries could in any way be controlled by external Parliamentary examination. The use of committees of inquiry is much less frequent in Parliament than in some other legislatures; partly because of the relation of the Government to Parliament and partly because the House of Commons itself is jealous of giving up its powers of criticism to a committee. For this reason the two well-established committees, on Public Accounts and on Estimates, can only report to the House, which may, or may not, take any notice of their reports. Nevertheless, they have proved themselves very effective watchdogs on public expenditure; but they are dealing with expenditure of cash annually to departments, a very different thing from the commercial transactions of vast trading organisations.

On the initiative of the Government, the House of Commons has now set up the proposed committee, but with even more restricted terms of reference. It can only deal with current policy and practice, and its terms of reference exclude matters within the responsibility of the Minister; matters, such as wages and hours, normally decided by collective bargaining; matters for which other formal machinery has been established by Statute (e.g., railway charges); and matters of day-to-day administration. Whether, within these narrow limits, it can perform a useful function remains to be seen. The committee includes two chartered engineers, one electrical and one mechanical, both on the Labour side.

* * *

STABILISING LAKE NYASA

During the past week the Government of the Federation of Rhodesia and Nyasaland published the report by Sir William Halcrow and Partners on the Shire Valley project. The river Shire leaves Lake Nyasa (Africa's third largest lake) at the southermost point of the lake and runs southward to join the Zambesi about 100 miles from the latter's estuary in Portuguese East Africa. The project is for the control of the waters of Lake Nyasa (which at present may rise and fall by as much as 30 ft.) and of the river itself; for production of hydro-electric power; reclamation of the Lower Shire marshes; and for an appropriate system of communications. The total cost is put at about £80 million and the first stage, which would have to be completed before any significant returns materialised, is estimated to cost £23,500,000. This first stage provides for regulation of the outflow from the lake by a seasonal bund at Liwonde; construction of a major barrage and power station at Matope; and modifications to roads and railways, as well as river dredging and extensive irrigation.

Stabilisation of the lake and river will provide an immediate improvement in transport facilities, allowing the construction of better jetties and the wider operation of lake steamers, thereby significantly increasing the system of communications in the area. Development of a river port at Matope, within 36 miles of Blantyre, the commercial centre of Nyasaland, would have many advantages for it would establish an easy route nearly 430 miles long running almost true north and south down the African continent.

Nevertheless, the report shows that the project demands the simultaneous development of saleable hydro-electric power. This power would then be available to assist in the development of a number of industries: the manufacture of cement (which can, at present, cost £15 per ton in this area) and fertilisers, the exploitation of local bauxite deposits and the general development of agriculture, particularly cotton and rice, and of public health schemes. Part of the power would be exported to Portuguese East Africa and, on this understanding, the Portuguese authorities would meet about a third of the cost.

Whether or not the Federal Government will feel able to accept the report and go ahead with the project is a matter for conjecture. It is less than a month since the Prime Minister, Sir Godfrey Huggins, announced the decision to proceed with the £54 million Kariba project (Weekly Survey, March 11), and commencement of work there depends on adequate financial assistance being advanced by the World Bank. Two questions arise: can the Federation undertake two major hydro-electric schemes simultaneously, and will the World Bank be willing to support both schemes before it is known if even one of them can be operated successfully and the power produced sold to industries that have yet to be established?

* * *

OPENING-UP EAST AFRICA

In contrast to the speculation on the possibility of the World Bank providing monies for one or both of the Kariba and Shire projects, it was announced last week in Nairobi that the Bank has made a loan of 24 million dols. (about £8,500,000) to help finance new communications in Kenya, Uganda and Tanganyika. The loan will be used for the expansion of railways, roads and deep-water harbours. In the post-war period a £60 million programme has been planned and the work, begun in 1949, should be nearing completion by 1957. The loan will pay for part of the cost of imported equipment required from now on. Much of this equipment, particularly transport machinery, will be obtained from the United Kingdom with sterling.

During the period from 1946 to 1953 it has been estimated that the ton-miles of East African railway traffic have increased by as much as 80 per cent.—a clear measure of the need for modernisation and extension that is required in the area. Likewise, the East African ports have also suffered from inadequate capacity, though the works already undertaken at Dar-es-Salaam have gone part way to overcome these latter difficulties. Throughout the area there are vast mineral deposits still to be exploited and extensive tracts of fertile land requiring regulated irrigation before they will produce

their latent food crops. First, however, communications must be opened up and public health standards of the native raised; only then will the local communities develop, in turn bringing a further demand for the products of West European and American industry.

There can be little doubt that these areas of East Africa and the Federation territories to the south could be industrialised rapidly for the benefit of both the African community and the world generally if the necessary money were forthcoming. But they are not the only member countries with a call on the World Bank. One request for assistance has just been accepted. But how much, it must be asked, can and will the Bank find for one limited area, however large it is.

* * *

COMETS FOR B.O.A.C.

Statements last week by British Overseas Airways Corporation and the de Havilland Aircraft Company, Limited, announced that the Corporation have ordered 20 Comet aircraft of a new mark, which will supersede the Mark 3 Comet, with improved Rolls-Royce Avon engines, a redesigned and strengthened fuselage, and greater fuel capacity.

The Mark 4 Comet will have RA29 Avon engines which give an additional take-off thrust of 500 lb. and show a 9 per cent. improvement in specific fuel consumption. The aircraft will carry 58 passengers over a stage length of 2,870 miles against a 50-m.p.h. headwind. In effect, this means that B.O.A.C. will be able to fly from London to Johannesburg with traffic stops at Cairo and Nairobi. On the North Atlantic route the Comet 4 will be able to carry its full capacity payload from London to Gander (Newfoundland) with full fuel reserve.

De Havilland state that B.O.A.C.'s decision to concentrate on this new mark will facilitate their production programme because it permits an earlier introduction of the advanced version of the Comet, which is likely to interest the most important international airline operators, including those who had ordered the Comet 3. Being a straightforward development of the latter, the design is well advanced, and flight trials of the Comet 3 have enabled reliable performance estimates to be made for the Mark 4.

B.O.A.C. is negotiating with de Havilland for the earliest possible delivery of a new type of Mark 2 Comet to be fitted with RA29 engines. This aircraft will be used for intensive flight trials for building up engine hours and crew experience. Delivery of the first Comet 4 is expected in 1958.

The improved and strengthened Comet 2 will be offered by the de Havilland company for medium-stage intercontinental routes at an earlier date than the Comet 4. They will be to the same specification as those ordered for R.A.F. Transport Command, and one of the first models will be subjected to repeated-loading tests in the pressure tank.

* * *

AMERICAN GAS TURBINE TO BE BUILT IN BRITAIN

On another page in this issue appears a description of the American "Mars" gas turbine, a small portable power plant which is to be made under licence in this country. An agreement with this object has been concluded between the Solar Aircraft Company, San Diego, California, and William Sugg and Company, Limited, Regency-street, London, S.W.1, and a new company known as Sugg Solar, Limited, has been formed as a subsidiary of the British company to manufacture the engine.

The turbine, which weighs only 100 lb. and will fit into a 2-ft. cube, is rated at from 40 to 60 h.p., and is suitable for use in combination with pumps or generating plant. It is employed by the U.S. Navy in fire-fighting installations and has a special application as an auxiliary power unit in aircraft. It is designed to burn a considerable range of fuels.

The new British company, which is to manufacture the turbine for both military and industrial uses at Crawley, Sussex, has an initial capital of £150,000 and will have licence rights not only in the United Kingdom but also in Europe and all Commonwealth countries excluding Canada. The licence covers the present applications of the Mars engine, other applications now under development, and any that may arise in the future. The chairman of Sugg Solar, Limited, will be Mr. R. W. Young, and the managing director Mr. W. T. Mattock; both are directors of William Sugg and Company.

Announcing the formation of the new company, Mr. Edmund T. Price, president of the Solar Aircraft Company, said in San Diego: "While several British gas turbines and turbo-jet designs of such firms as Rolls-Royce, Bristol and Armstrong Siddeley have been licensed to U.S. companies, this is the first American gas-turbine unit to be licensed in Britain."

* * *

DROP FORGERS' STEEL

The various motor-vehicle manufacturers who are to carry out large expansion programmes have not always been explicit enough, perhaps, in the information given to their suppliers concerning their future requirements, and machine-tool manufacturers, for example, may consequently have difficulty in organising their production schedules. This is not the case with drop forgers, about half of whose output is for motor vehicles, and who have a fairly exact knowledge of their future commitments. Unfortunately, they have been informed that the British Iron and Steel Federation is unable to assure them of adequate steel supplies. Mr. S. Bramhall, President of the National Association of Drop Forgers and Stampers, told his audience at the Association's annual meeting on March 15 that the industry had been promised a small increase in steel supplies this year which might meet immediate requirements, but that it appeared almost certain that the drop forgers would eventually have to import substantial tonnages. Total deliveries of steel for drop forgings, laminated springs, etc., which were averaging 9,900 tons a week in the fourth quarter of 1953, had already increased to 11,900 tons a week in November, 1954.

The quality as well as the quantity of the steel has been causing concern to the drop forgers. Clients are now demanding a standard of inspection far higher than a few years ago and, consequently, require the fullest co-operation from their steel suppliers if the finished products are to be acceptable. Moreover, there is some room for improvement in the price structure of the drop-forging industry, and the Association have been taking steps to secure some uniformity among manufacturers in the methods of adjusting their prices to deal with changes in steel costs, wage rates, and other factors. Rationalisation of this sort can be in the best interests of consumers as well as the drop forgers who have certainly never been guilty of charging excessive prices. Whereas steel, which accounts for half the total manufacturing and selling costs, has risen in price by 220 per cent. since 1938, the price of drop forgings has increased by 110 per cent. only.

* * *

DU PONT DE NEMOURS

The annual report of E.I. Du Pont de Nemours and Company is always of considerable interest since the company, with its manifold activities, is a useful indicator of the state of the United States economy. This year the results contain very convincing evidence of the recovery from the recent recession. Total sales in 1954 were 3·5 per cent. less than the record level of 1·75 million dols. in 1953, but in the final quarter of the year they were running about 10 per cent. higher than in the fourth quarter of 1953.

It says much for the company's operating policy that investment was substantially increased at a time when sales were falling. The total capital employed in the business in 1954 rose to 1,996 million dols., 7 per cent. more than in 1953. Expansion programmes on hand include the erection of two new plants for the manufacture of neoprene synthetic rubber, tretraethyl lead and "freon" refrigerants. Capacity for the manufacture of synthetic fibres, plastics and titanium is also being increased. Du Pont's research facilities are amongst the most extensive in the world. Expenditure on research in 1954 amounted to 61 million dols. exclusive of laboratory construction costs. Work has begun on the erection of three additional laboratory buildings at the experimental station near Wilmington, Delaware, and when these are completed in 1956 there will be about 1,000 workers at the station—about half the total number employed by the company. The experimental station is concerned primarily with long-range research aimed at diversifying the company's products. The discovery there of a new class of synthetic crystalline polymers, provided the foundation for the development of nylon and the more recent "dacron" and "mylar."

Textiles are now the largest single item in the company's sales, but its multifarious activities include petroleum refining, tanning, printing, mining and the manufacture of a range of engineering products. It is also responsible for building and operating the Atomic Energy Commission's Savannah River Plant, the major portion of which has now been completed at a cost of over 1,000 million dols. The company has, not surprisingly, sometimes fallen foul of the U.S. anti-trust laws. Recently, the joint ownership with Imperial Chemical Industries of three companies in Canada, Argentina and Brazil had to be terminated, but the company was more fortunate in a suit concerning the holding in the General Motors Corporation which provides over one-quarter of its total annual earnings. The Government were unable to prove "conspiracy, monopolisation, or restraint of trade," and the case was dismissed.

* * *

POWER IN THE WIND

Wind is a dependable source of energy but an unreliable source of power. Variations in the annual average wind speed at any site do not generally exceed 10 per cent. on either side of the long-term mean, but it is impossible to rely on a wind-driven machine to produce power at a given time. The only solution is some way of storing the energy until it is required. These problems are discussed in an article in this issue which describes in detail an aero-generator that has been built as part of the British Electricity Authority's investigations into the use of wind power. The problems will also be discussed in a subsequent issue, which will contain an account of a paper entitled "Electrical Energy from the Wind," given by Mr. E. W. Golding, M.Sc.Tech., M.I.E.E., to the Institution of Electrical Engineers.

Besides the variability of the wind, another disadvantage is that a large rotor is required to extract an appreciable quantity of power from the wind. An aero-generator with a 50-ft. diameter windmill has a net output of about 100 kW. Although the wind costs nothing, the structure must be exceptionally robust to withstand the high winds expected at the sites chosen, and the control gear is ideally designed for unattended operation.

There may be difficulties in extracting energy from the wind, but they certainly present a challenge to the engineer. The B.E.A.'s plant at Prae Wood is one of the most interesting approaches to the challenge, and it is one which appears to be readily adaptable to much larger outputs without undue complication. At present the plant is waiting for wind of sufficient force, when it will feed energy into the national grid via the Eastern Electricity Board's distribution network.

THE EDUCATION OF THE CHEMICAL ENGINEER

INTERNATIONAL DISCUSSION OF TRAINING METHODS

A conference on "The Functions and Education of the Chemical Engineer in Europe" was recently held at Church House, Westminster, London, S.W.1. It was organised by the Institution of Chemical Engineers, in co-operation with the Department of Scientific and Industrial Research, for the European Productivity Agency of the Organisation for European Economic Co-operation, and took place from Monday, March 21, to Wednesday, March 23. The attendance numbered about 400 and included delegates from the "non-iron-curtain" European countries, as well as from South Africa. The object was to call attention to the necessity for more chemical engineers and more schools of chemical engineering; for more financial aid for chemical engineering research; and for a more general recognition of the part that chemical engineering is playing in modern industry.

The conference was opened by the Lord President of the Council (the Marquess of Salisbury, K.G.,) who said that chemical engineers were now playing essential parts in the fields of fuel, food preservation, processing of raw materials, plastics and atomic energy; and he felt sure that a discussion of their activities, with which the conference opened, would provide useful information regarding the methods of educating the personnel who were so urgently required in this country. The international character of the conference should further lead to an interchange of information, which could not fail to be of the greatest value.

M. R. Gregoire, deputy director of the European Productivity Agency, in thanking Lord Salisbury for his attendance, gave a short review of the work that was being done in chemical engineering by is organisation and emphasised the need for co-operation throughout Europe in these activities.

ROLE OF THE CHEMICAL ENGINEER

The first session was presided over by Sir Harold Hartley (United Kingdom) and five papers dealing with "The Part Played by the Chemical Engineer in Bridging the Gap between Research and Plant Construction" were presented for discussion. In the first of these Sir Christopher Hinton said that people working on the design of a plant ranged from the pure scientists, who need have little or no knowledge of design and operation, to the engineer, who required little knowledge of the scientific principles underlying the process. Chemical engineers fitted into the pattern between these two extremes and this emphasised the need for adequate facilties for their training. He did not think that any absolute answer could be given to the question of how best to train an engineer. The difficulty was to devise a course during which the student could learn what it was desirable for him to know without spending too many years in academic study. It was men with the necessary theoretical and practical training and with an intelligent appreciation of the work of specialists in other branches who were needed.

Dr. Kurt Riess (Germany) said that in Germany process engineering had been created to bridge the gap between the chemist and the mechanical engineer. During the course less time was devoted to studying chemistry and more to mechanical engineering. While there was a close connection between the chemist and the process engineer, the former was entirely engaged in the improvement of the chemical process, while the latter assumed the responsibility of discovering the most economical method of translating laboratory results into full-scale production.

"HARSH ECONOMIC REALITIES"

Dr. L. Morandi (Italy) defined a chemical engineer as a technologist who had completed a university course in chemistry and who then played an active part in either manufacture or planning. The greatest call on his professional ability would be made when he had to design and carry through the construction of an industrial plant, a task which was governed by what might be called "harsh economic realities." He must be in a position to describe his work in appropriate economic terms to the layman. Above all, he must maintain continuous contact with the research chemist, so that they could between them devise processes, plan manufacture and work out methods of operation.

Dr. R. Holroyd (United Kingdom) pointed out that the closest collaboration between technical staff with different training was essential at every stage in the evolution of an industrial chemical project. It was valuable for a substantial proportion of the industrial technical staff to have had experience in more than one field, and the fact that chemical engineering courses of instruction varied considerably in character might well be more of an advantage than a disadvantage.

PLANT OPERATION AND MANAGEMENT

The afternoon session on Monday, March 21, over which Dr. K. Riess presided, was devoted to the consideration of four papers on "The Chemical Engineer in Plant Operation and Management."

Mr. J. A. Oriel (United Kingdom) said that it mattered little how well the plant had been designed or equipped with control devices; its ultimate efficiency was dependent on the operating crew. The chemical engineer engaged in operation was called upon to display some managerial qualities and it was here that a man with a sound educational background was of the greatest value. Such a man must regard himself as the leader of a team, the members of which must be taken as fully as possible into his confidence.

Mr. N. G. Chorine (Belgium) regretted that the number of chemical engineers in Belgium was less than it should be. A long term solution was to train men who would primarily be engineers rather than scientists, while more immediately all engineers who were playing an important part in the operation of chemical plants should be made aware of the techniques of chemical engineering.

Professor Dr.-Ing. K. Winnacker (Germany) said the experience of German industry was that it was not worthwhile to train technicians who were half chemists and half engineers. Management of a chemical works could only be successful if the chemist and engineer collaborated in a spirit of mutual understanding. It would then be obvious what were the duties of each. Similar considerations applied to administration, where the human factor was vitally important.

MODEL COURSES

At the meeting on Tuesday morning, March 22, "Model Courses of Study for a Primary Degree in Engineering" were discussed in seven papers. Dr. J. C. Vlugter (Netherlands) occupied the chair.

Professor Dr. K. Schoenemann (Germany) considered that chemical engineering training must be based on a knowledge of a number of typical manufacturing processes and unit operations. It must also include a general survey of the connection between raw materials and prices, as well as the main lines of technological development. Experience at Darmstadt had shown that it was possible to have a general introductory course of chemical engineering without overburdening the student. This was now an obligatory subject for all types of chemists.

Professor T. R. C. Fox (United Kingdom) said that education was a compromise between breadth and depth; and he would maintain that many technological courses were too broad rather than too narrow. The young chemical engineer was too often confused by theories or drowned in facts, or both. University education was only a beginning, and it was a council of despair to plan courses on the assumption that when practice began learning ended. The time of the student should be devoted mainly to the core subjects of chemical engineering: those designed to expound basic scientific principles, those concerned with the applications of those principles to design, and those intended to foster an experimental outlook. Over all three groups the build-up of ideas should be continuous. Much of the basic study should continue for the full duration of the course, and much thought should be given to methods of introducing and reintroducing the difficulties over which students stumbled.

In Germany, according to Professor Dr. Ing. E. Kirschbaum, the basic training of the chemical engineer was the same as that of the mechanical engineer. Students were, however, taught the principles of chemistry during that period and in the later stages less time was spent on the design of prime movers, the time being occupied with the design of process equipment, chemical technology and organic and physical chemistry. Particular importance was attached to training in design, and close contact was established with research. Details of the training of chemical engineers at Liége were given by Professor J. Danze (Belgium) at Delft by Professors P. M. Heertjes and H. Kramers (Holland), and in Vienna by Professor K. G. K. Peters (Austria).

POST-GRADUATE COURSES

In the afternoon the chair was occupied by Professor F. G. Garner (United Kingdom), and Mr. C. J. Borelius (Sweden) described the courses available in chemical engineering at the Royal Institute of Technology, Stockholm, and the Chalmers Institute of Technology in Gothenburg. Mr. M. B. Donald and Mr. J. M. Coulson (United Kingdom) thought that the final developments of the techniques of chemical engineering required a combination of chemistry, chemical engineering and mechanical engineering, and it was a great asset to have several men trained in any two of these fields.

Professor S. G. Terjesen (Norway) pointed out the importance of a study of process control. This forced the student to look at his project from the operational point of view. As a pattern of thought the theory of automatic control ranked very high and a chemical engineer who could think in terms of closed-loop systems was better than one who could not. Mr. R. W. Blount (United Kingdom) described the place of the part-time course in our educational system, and its importance in the training of the professional engineer, while Mr. G. U. Hopton (United Kingdom) gave details of the examination of the Institution of Chemical Engineers.

At the meeting on Wednesday morning, March 23, the chair was taken by Professor M. Letort (France) and four papers were presented on the practical training of the chemical engineer before and after entry into industry. Mr. F. H. Pugh gave an account of the methods adopted by the Royal Dutch/Shell Group in the Netherlands for training chemical engineers in refineries and chemical plant and in the development of processing equipment. Courses for specialists, such as materials and corrosion engineers, and for instrumentation engineers were also described.

PART-TIME AND VACATIONAL TRAINING

A paper by Mr. J. P. V. Woollam and J. M. Solbett (United Kingdom) urged the need for a two-years post-graduate training scheme to bridge the gap between the outlook of new graduates and the great body of established practical men. The work of turning graduates into practical men was, they pointed out, the

responsibility of industry. Every effort ought also to be made to impart theoretical chemical-engineering knowledge to the largest number of non-graduate personnel by part-time study. Professional institutions could help a great deal to increase the awareness of the part that chemical industry ought to play in industry.

The scheme for the vacational training of undergraduates, especially chemical engineers, in the petroleum-refining division of British industry was described by Mr. D. Morten (United Kingdom), while the work of the International Association for the Exchange of Students for Technical Experience was dealt with by Mr. J. Newby (United Kingdom). The broad educational value of this body's activities was generally recognised and the result would be to provide industry with an improved human potential for productivity.

CHEMICAL ENGINEERING RESEARCH

The closing session on Wednesday afternoon, March 23, over which Sir Harold Hartley (United Kingdom) presided, considered six papers on the general subject of chemical-engineering research.

Professor J. Cathala (France) said that, for the study of its particular problems, chemical engineering must have recourse to calculation by graphs and dimensional and statistical analysis. Research was necessary to augment the strength of these methods. In fact, for the solution of a particular problem chemical engineering often suffered from an absence of numerical data and it was indispensable to develop approximate methods for estimating the missing information. These problems could only be solved by co-operation between specialists, teams of investigators, teaching establishments and industrialists. Industry ought not to reserve for itself the privilege of conceiving, calculating and working up new procedures. Teaching establishments could play an equally important part in this domain.

In describing the organisation of research in process technology in Germany, Dr. H. Miessner said that the bulk of this was still conducted by industry which, however, co-operated closely with the technical colleges. Mr. A. S. White (United Kingdom) considered that development was being handicapped by lack of information, not only of the properties of materials, which were needed as parameters in design, but by an insufficiency in design methods themselves. Improvement could come from basic research in the universities and from critical surveys and reviews by organisations such as the Department of Scientific and Industrial Research, although the valuable work done by some sections of industry and by the various research associations must be acknowledged.

FUTURE OF PROCESS ENGINEERING

Dealing with future needs, Professor D. S. Kiesskalt (Germany) said that developments in all branches of chemical technology indicated a trend towards continuous processes with higher pressures, higher temperatures and higher flow densities. More regular products were thus obtained and valuable materials such as silver, tantalum, titanium and the molybdenum alloys could be used for constructional purposes. As regards plant, ultra-centrifuges for the separation of solids from liquids and liquids from liquids were still lacking, as was liquid-liquid diffusion apparatus.

Professor Dr. Ir. P. M. Heertjes (Holland) pointed out that greater attention must be paid in future to fundamental research. This would necessitate better equipped laboratories and better paid staff. The financing of research should be on a long-term basis and the research worker should have greater freedom, especially in industry, than at present.

In a final paper, Professor D. M. Newitt (United Kingdom) dealt with the scope and nature of the research which could be appropriately undertaken in a University Department of Chemical Engineering. Although the facilities available would usually impose limitations on the scale of experimental work the results might constitute a valuable contribution to chemical engineering practice. In particular, the use of models based upon data obtained from large scale plant afforded the student an opportunity of becoming acquainted with industrial operations and of developing procedures for dealing with the larger number of variables that it was now customary to use.

* * *

ELECTRICITY SUPPLY TARIFFS

Progress towards Standardisation

Since the days of John Hopkinson and Arthur Wright the structure of tariffs for the supply of electricity has been a constant matter of interest and controversy. One result has been the exercise of a good deal of ingenuity—some of it misplaced—in the endeavour to establish a correct relationship between cost and price. Another has been that when the Area Boards undertook the tasks of simplification and standardisation, laid upon them by the Electricity Act, 1947, they found that more than 5,000 different tariffs were in force.

What has since been done to regularise this intricate situation is described in a paper read before the Utilisation and Supply Sections of the Institution of Electrical Engineers by Messrs. A. O. Johnson and N. F. Marsh on Thursday, March 17. From this it appears that by the end of 1953 thirteen of the fourteen Area Boards had standardised their domestic tariffs, with the result that 67·5 per cent. of the consumers were paying on the variable-block system, based on the number of rooms occupied, and 19·3 per cent. on two-part tariffs, mainly based on floor area.

At the end of the same period nine Area Boards had also introduced standard industrial tariffs, seven of which, covering 48 per cent. of the consumption, were based on the measured maximum demand and were either of the two- or three-part type. At present the structures of these tariffs vary but that is a drawback which it is hoped time will cure. On the other hand, 49·3 per cent. of the commercial consumers were supplied on flat rates, 27·6 per cent. on two-part tariffs, and 21·55 per cent. on block tariffs. Nine Area Boards had standardised their farm tariffs, nearly three-quarters of the consumers involved being supplied on the variable-block system.

The authors therefore contend that good progress has been made towards the twin goals of standardisation and simplification, although constant review will always be necessary. The increasing use of electrical appliances may, for instance, lead to the wider adoption of fixed-block tariffs for domestic, farm, commercial and small industrial consumers on the ground of simplicity. Simplification of maximum-demand tariffs will also result as a closer relationship is established between the demand and energy charges.

* * *

ELECTRICITY SUPPLY IN FEBRUARY

During February, 6,628 million kWh were sold by the British Electricity Authority to the Area Boards. This was an increase of 10·1 per cent. over the figure for February, 1954. When corrected for weather conditions the figure was 11·3 per cent.

The amount of electricity sent out by the Area Boards during February was also 6,628 million kWh, of which amount 133 million kWh were supplied direct by the Central Authority. The increases in the amounts sent out, compared with the corresponding figures in February, 1954, were 9·8 per cent. in the "mainly industrial," and 9·0 per cent. in the "mainly non-industrial" areas.

Letters to the Editor

LOW-FRICTION FLUID SEALS

The Quip Modest

SIR, I read "The Retort Courteous" in your issue of March 11 with a feeling closely akin to depression and frustration. The essence of Mr. Watson's letter is not new but rather a masterly version of the reply received when one approaches a manufacturer for information relating to the friction of seals under specific conditions. However, I wish to emphasise that it was not, nor is it now, my intention of making this an issue with Messrs. James Walker and Company, Limited. It so happens that the article concerning one of their products presented an opportunity to make a plea for information; a plea which I constantly hear repeated up and down the country from designers who have to use some form of seal.

Whilst it is possible that my letter over-simplified the complexity of the problem, the reply gives the impression that it is one to which there is no answer, and this is incorrect. It is reasonable for a customer to request, and expect to receive, information regarding the goods he proposes to buy. There is no reason why fluid seals should be privileged in this matter, and perhaps, after sealing efficiency, the friction is the most important property of a seal. In designing, say, a spring- or pressure-operated valve, it is of the greatest assistance to know that the frictional effort will be 5, 50 or 500 lb. Whilst I lay no claim to great experience, I do not recall a case in which any manufacturer has been ready to give the rough order of the effort.

If more and more designers would make a point of pressing the manufacturers for information until they become heartily sick of the constant nagging, as many of them including Mr. Watson are of hearing my views on the subject, then perhaps to put an end to it they may get down to producing the required figures.

Yours faithfully,

B. COOKE.

Research Department,
Vickers-Armstrongs Ltd.,
Elswick Works,
Newcastle-upon-Tyne, 4.
March 16, 1955.

* * *

WEIGHING THE OUTPUT OF A COLLIERY

SIR,—Referring to the letter from Mr. J. H. Gold published on page 293 of your issue of March 11, we are interested in his comments upon the article describing the Pooley automatic weighing equipment recently installed at Whitwick Colliery, and thank him for pointing out that certain advantages might be obtained if the weighing and totalising mechanism could also provide printed records of individual tub weights, and a coding system.

The installation at Whitwick was designed to fulfil the requirements at that colliery. We have in other cases fitted individual tub-weight recorders, but up to the present we have not been asked for a combination of this and totalising, in connection with colliery work. Should this feature be specified for future installations, we would be prepared to consider the ways and means of providing suitable equipment.

The machine at Whitwick is, however, fitted with a counter recording the number of tubs being weighed. By means of this the average weight of a batch of tubs from any one district can be checked to give that guide to the quality of coal which Mr. Gold mentioned.

Yours faithfully,

L. H. BROADBENT,
Henry Pooley and Son, Limited.

Somerset House,
37 Temple-street,
Birmingham,
March 14, 1955.

Obituary

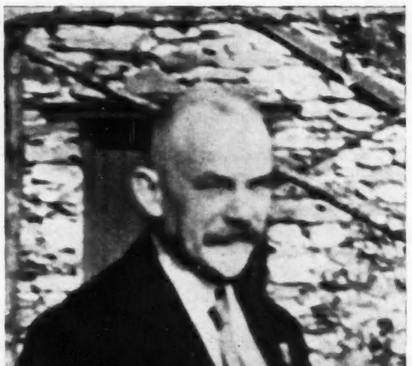
ENGINEER CAPTAIN EDGAR C. SMITH, O.B.E.

The History of Science and Naval Engineering

It was with a deep sense of personal loss, which will be shared by very many of our readers, that we recorded briefly in last week's issue the death on March 13, of Engineer Captain Edgar C. Smith, O.B.E., R.N.(ret.), for more than 51 years a contributor to our columns. He wrote on a variety of subjects and was a specialist in technical and scientific biography, but the study to which he had devoted himself most assiduously, and by which he is most likely to be remembered, was that of the history of the Engineering Branch of the Royal Navy. As an authority on that subject, he enjoyed a status that has long been unique and which was richly deserved; for it is beyond question that, but for his personal investigations, much of the evidence bearing upon the origins and early development of naval engineering would have been irretrievably lost.

Edgar Charles Smith was born at Newport Pagnell, Buckinghamshire, on May 5, 1872. He was the son of a schoolmaster, George Charles Hooper Smith, who, in the following year, moved to Gravesend. It was on Thames-side, therefore, that the young Smith received his general education, in his father's school; an education, however, which from the start had a strong scientific bent. At the age of 16 he entered Finsbury Technical College, where he studied for a year under Professor John Perry and Professor Silvanus Thompson; but his own leanings at that time were rather towards handicrafts than theory and, at his own request, he left Finsbury in 1889, to enter the small factory of a relative, Charles Hooper, who made walking sticks and umbrellas and their metal fittings in the village of Thrupp, near Stroud, Gloucestershire. In the following year, seeking wider experience, he went to the engineering works of Strachan and Henshaw, Limited, at Bristol, working at the bench during the day and attending classes at the Merchant Venturers' College in the evenings. Then, after a further short spell with Charles Hooper, he was engaged by T. H. and J. Daniels, Limited, in their general engineering works at Stroud; then by A. G. Mumford, Limited, Colchester, who at that time were well-known as makers of machinery for naval picket-boats; and, in 1894, returned to Gravesend, where, for a short period, he taught in his father's school. It was while he was so employed that he learned that there were vacancies for "Assistant Engineers for temporary service" in the Royal Navy. He was one of five candidates at his interview, and was placed first of the three who were accepted; and on March 11, 1895, he joined H.M.S. Pembroke, the screw-propelled wooden ship-of-the-line which was then the depot ship at Chatham.

His progress during the next 27 years from Assistant Engineer to Engineer Captain was described in detail in the series of articles which he contributed to ENGINEERING between January 28, 1944, and December 27, 1946; a series in which his personal experiences provided the framework for a truly remarkable survey of naval ships, engines, dockyards, personnel and practices. It is sufficient to state here, therefore, that he served in succession in the scout Fearless, the battleships Trafalgar and Sans Pareil, the cruiser Blenheim and the battleship Barfleur; saw service on land in China during the Boxer rising; acted as an instructor in H.M.S. Britannia at Dartmouth and went to Bermuda in the cruiser Highflyer with the last "term" of Britannia cadets; spent 18 months as chief engineer in the destroyer Orwell and 20 months as senior engineer of the cruiser Carnarvon, followed by three years as assistant to the Chief Engineer at Hong Kong Dockyard—from which he returned to England via Russia; and was at sea for nearly two years during the 1914–18 war



in the cruiser Minerva and the battleship Magnificent. Finally, he was for rather more than 4½ years on the staff of the Manager of the Engineering Department at H.M. Dockyard, Devonport, retiring in 1922 on attaining the prescribed age limit of 50. It is a curious circumstance that, although the name of H.M.S. Viper, the first turbine-propelled warship, appeared in the *Navy List* only three years and three months after Smith entered the Navy, he never served in a turbine-engined ship.

In the issue of ENGINEERING of December 25, 1903, on page 855, there appeared a short article entitled "Naval Boilers": a concise factual summary of the types of boilers in use, and the extent of their adoption, in the principal navies of the world. This was Captain Smith's first contribution to our columns—and his last on a subject of current engineering technology; for he realised, too late to do anything about it, that he had transgressed seriously by omitting to obtain Admiralty sanction for its publication. Fortunately, it was unsigned, and, in any case, it was based on information that was available to the public, so that no question of national security was involved; but he resolved then and there to avoid such topics in the future and to restrict his literary efforts to scientific and technical history. In so doing, he was able to indulge a natural inclination that had been fostered by his father's interest in all matters scientific; and he was further helped by the fortuitous circumstance that H.M.S. Orwell, in which he served from July, 1906, to January, 1908, went into dock for some months at Leith for the repair of collision damage. This enabled him to explore the bookshops of Edinburgh, in one of which he bought for £1 the eighth (1856) edition of the *Encyclopædia Britannica* and so laid the foundation of his eventual great collection of scientific biographical material.

During 1907, he sent us memoirs of Benjamin Robins, inventor of the ballistic pendulum, of the Bernoullis and of Leonard Euler; the last of which, especially, established him firmly in the good opinion of Dr. W. H. Maw, then Editor of ENGINEERING, as a writer of original outlook and painstaking exactitude. Many other contributions followed. In 1919, on Maw's suggestion, he wrote for us an article on James Watt, the centenary of whose death was to be marked later in that year by a three-days commemoration in Birmingham. As a result, he was invited by the then Engineer-in-Chief of the Fleet, the late Engineer Vice-Admiral Sir George Goodwin, to accompany him to the Birmingham ceremonies as a second representative of the Engineering Branch of the Navy. Smith did so, and thus was brought into contact with the founders of the Newcomen Society for the Study of the History of Engineering and Technology—Arthur Titley, John Willim Hall, Dr. H. W. Dickinson, Dr. A. P. Thurston and others—and lost no time in becoming a member of it. Though, as he has recorded, he took no personal part in its formation, he was appointed to the Council at the outset and remained on it to the end of his days. He was President of the Society in 1937-38 and contributed to its *Transactions* a round dozen of valuable papers on the history and development of marine and especially of naval engineering. It was characteristic of him thus freely to publish the knowledge that he had so laboriously acquired; for, though he relied to a great extent upon his pen for his livelihood after leaving the Navy, no man could have been more generous in placing at the disposal of any genuinely interested inquirer the great store of historical information and the documentary resources that he had accumulated in his many years of research.

So far as we are aware, Captain Smith wrote only one book, the excellent *Short History of Naval and Marine Engineering* which was published by the Cambridge University Press in 1938; but his other writings were voluminous. In addition to his articles in ENGINEERING, not all of which were signed, he contributed scientific biographies and other commemorative notes to *Nature* for more than 30 years, the most recent being one on "The Copley Medal and Its Founder," in the issue of December 4, 1954—only a few weeks before he went into hospital for a major operation. He made a good, if rather slow, recovery, but for a long time he had also suffered from a weak heart, and it was from a heart attack that he died. For many years it had been his special interest to seek out, like another Old Mortality, the graves and memorials of men eminent in science and engineering, and, where necessary, to stimulate public support for their care and preservation; not from any motive of mere sentimentality, but from a deep conviction of their educative value as landmarks in the development of civilisation. It is fitting that his own grave in the churchyard at Burstow, Surrey, should be not far from the tomb of one of the greatest of the men whom he held in such honour—John Flamsteed, the first Astronomer Royal, who was rector of Burstow from 1684 until his death in 1719.

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We regret also to record the death of:

MR. GEORGE RATCLIFFE, on March 12, at the age of 51. He was deputy service manager of Rolls-Royce Ltd., (oil-engine division), Sinfin, Derby.

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THE WHITWORTH SOCIETY

It is possible that when Joseph Whitworth conceived his scholarship scheme he was not concerning himself with training recruits for the mechanical branches of the Army, but in view of his later active intervention in the armaments industry, and the present-day development of mechanisation, it is likely that he would have found the occupancy of the presidential office of the Whitworth Society by a professional soldier entirely fitting. Major-General A. R. Valon, who holds that position, presided at the 30th annual commemoration meeting and dinner, held at Simpson's in the Strand on March 17.

When replying to the toast of "Success to the Whitworth Society," proposed by Dr. J. W. Drinkwater, General Valon gave a racy and interesting account of the engineering aspects of his army career. The changing conditions in the field of armaments, and in most other major branches of engineering, call for scientific knowledge different in extent, if not in degree, from that ruling in Whitworth's day. The institution of Senior Scholarships, and other changes, mark the effect of modern progress on the Whitworth foundation, but the value of practical experience, on which he laid stress, has not diminished. Professor Hugh Ford, who proposed the toast of "The New Whitworth Scholars, referred in somewhat different terms to the same matter. This toast was replied to by Mr. A. D. Carmichael, who stated that his scholarship was taking him to Cambridge University. It was announced that Dr. R. W. Bailey would follow General Valon in the presidential chair.

PERSONAL

The Diploma of Fellowship, F.C.G.I., has been conferred upon five past students of the City and Guilds College, London, namely, MR. A. MCL. MOONEY, C.B.E., A.C.G.I., M.I.E.E., deputy director of electrical engineering, Admiralty; SIR RALPH REED, A.C.G.I., retired, lately chairman of Albert E. Reed & Co. Ltd., paper manufacturers; DR. E. H. RODD, A.C.G.I., D.I.C., F.R.I.C., retired, formerly with Imperial Chemical Industries Ltd.; MR. N. E. ROWE, C.B.E., A.C.G.I., D.I.C., B.Sc., M.I.Mech.E., F.R.Ae.S., technical director, Blackburn and General Aircraft Ltd., and MR. C. W. SPEIRS, J.P., M.I.E.E., F.Inst.P., retired, formerly with the Morgan Crucible Co. Ltd.

MR. A. O. BLUTH, vice-chairman and joint managing director of the Jack Olding Organisation and a director of Vickers Armstrongs Ltd., has joined the board of Vickers Ltd., Vickers House, Broadway, London, S.W.1.

SIR THOMAS FRAZER, O.B.E., has been appointed a member of the Iron and Steel Holding and Realisation Agency by the Chancellor of the Exchequer.

SIR EDWARD C. BULLARD, M.A. (Cantab.), Sc.D., F.R.S., is resigning his position as director of the National Physical Laboratory, which he has filled since 1950. He is to undertake research on geophysics at the University of Cambridge and has been awarded a Fellowship by Caius College.

MR. W. W. WOOD, A.M.I.C.E., M.I.E.E., has retired from the position of general manager of Pirelli-General Cable Works Ltd. which he has held since 1940, but remains a director of the company. He has been succeeded as general manager by MR. J. R. HARDING, B.Sc. (Eng.), M.I.E.E., hitherto assistant general manager.

MR. J. R. DALLMEYER, B.Sc., A.M.I.C.E., has been confirmed in the position of assistant civil engineer, Eastern Region, British Railways, King's Cross, which post he has been filling in an acting capacity since February, 1953.

MR. D. J. C. ROBERTSON, C.B.E., B.Sc., A.M.I.Mech.E., A.M.I.E.E., has been appointed to succeed the late MR. NORMAN HADDON, M.I.Loco.E., as production general manager and as a director of Metropolitan-Cammell Carriage and Wagon Co. Ltd., Metropolitan-road, Saltley, Birmingham, 8, and also as a director of Metropolitan-Cammell Weymann Ltd.

The Ministry of Supply announce that MR. J. HANSON has been appointed chief superintendent, Aeroplane and Armament Experimental Establishment, Boscombe Down. MR. C. DUNBAR has been appointed deputy chief engineer (tracked vehicles) at the Fighting Vehicles Research and Development Establishment, Chertsey, Surrey.

MR. W. J. KNIGHT, M.B.E., assistant engineer-in-chief, Cable and Wireless Ltd., Electra House, Victoria-embankment, London, W.C.2, is to be deputy engineer-in-chief in place of MR. E. B. DILLOW, who retires on March 31. MR. R. L. SAUNDERS and MR. D. SCOTT are to be assistant engineers-in-chief in place of Mr. Knight. Mr. Saunders is engineer in charge of the company's development laboratory and production unit at Radio House, Wilson street, London, E C.2. Mr. Scott is responsible for the day-to-day operations of the company's network of wireless circuits. The above appointments will take effect on April 1.

MR. O. L. L. FITZWILLIAMS, B.A. (Cantab.), A.F.R.Ae.S., has been appointed chief engineer of Westland Aircraft Ltd., Yeovil, Somerset. MR. P. E. Q. SHUNKER, B.Sc. (Eng.), A.F.R.Ae.S., has been appointed chief designer and will take responsibility for the design of helicopters and fixed-wing aircraft. MR. W. D. MURRAY, F.R.Ae.S., has been appointed engineering manager.

MR. DAVID BRUCE and MR. H. O. HINTON, O.B.E., T.D., have been elected to the board of directors of H. Widdop & Co. Ltd., manufacturers of marine Diesel engines, Greengate, Keighley, Yorkshire.

MR. LEONARD G. PACKHAM has been elected to the board of directors of C. C. Wakefield & Co. Ltd., 46, Grosvenor-street, London W.1.

MR. E. A. HYDE, M.I.I.A., has been appointed deputy managing director, and MR. W. V. HODGSON, M.I.Prod.E., assistant managing director of A. C. Wickman Ltd., Coventry.

MR. W. E. HAMPTON has joined the commercial manager's staff of D. Napier & Son Ltd., Acton, London, W.3, in the newly-created post of aviation export representative.

MR. O. T. JONES, B.Sc. (Eng.), M.I.Mech.E., has retired from the position of chief automotive engineer, Vacuum Oil Co. Ltd., Caxton House, London, S.W.1, after 35 years of service. His successor is MR. C. G. TRESIDDER, A.M.I.Mech.E., A.F.Inst.Pet., A.M.C.T. MR. E. R. BLANE, A.R.I.C., F.Inst.Pet., associate technologist at the company's central laboratories, at Wandsworth, London, S.W.18, has retired after over 20 years of service. He is, however, remaining with the company for a limited period as a full-time consultant.

MR. H. E. TURNER has been appointed service and home sales manager, the Parsons Engineering Co., Ltd., Town Quay Works, Southampton.

J. and H. McLaren Ltd., Leeds, announce that MR. D. F. PICKERING, A.M.I.Mech.E., has been appointed assistant sales manager. MR. ERIC ROBINSON is now operating in the North-West area of England, and MR. JAMES MACKIE in South Scotland, as sales representatives. MR. T. J. GERRY has been appointed an assistant sales representative in the London and Home Counties area.

MR. L. KEARTON PARKER has joined Winston Electronics, Ltd., Hampton-hill, Middlesex, as chief sales engineer.

MR. J. PALMER REES, A.M.I.E.E., White Lodge, Ogmore-by-Sea, Glamorgan, has been appointed local South Wales representative for the land products of Richardsons Westgarth (Hartlepool) Ltd.

* * *

COMMERCIAL

THE ENGLISH ELECTRIC CO. LTD., Marconi House, Strand, London, W.C.2, announce that their offers, made through Lazard Brothers & Co. Ltd., to acquire all the ordinary stock of the VULCAN FOUNDRY LTD., and all the stock of ROBERT STEPHENSON & HAWTHORNS LTD., not held by the Vulcan Foundry Ltd., have in each case been accepted by the holders of more than 90 per cent. in value of the stocks concerned and, accordingly, have become unconditional.

DEWRANCE & CO., LTD., announce that an exclusive licence has been granted to ATELIERS JASPAR S.A., Liége, for the manufacture of Dewrance valves suitable for any pressure and temperature. The territory covered includes Belgium, the Grand Duchy of Luxembourg, the Belgian Congo and Ruanda-Urundi. The valves made under this licence will be known as "Jaspar-Dewrance."

FLIGHT REFUELLING LTD., Blandford, Dorset, are now developing plans for the manufacture in Canada of their complete range of aircraft pressure refuelling components. They will operate through a subsidiary company originally formed in Canada in 1948, FLIGHT REFUELLING (CANADA) LTD., which has established offices at 922, King-street, West, Toronto, Ontario.

MARTIN, BLACK & CO. (WIRE ROPES) LTD., Speedwell Works, Coatbridge, near Glasgow, have opened a stores depot at 99A, Webster-road, Liverpool. (Telephone: Sefton Park 6669.)

NORRIS BROTHERS, LTD., Perrymount Chambers, Haywards Heath, Sussex, have opened an additional drawing office, at 53, Victoria-street, London, S.W.1. (Telephone: ABBey 5444).

THE WHARTON CRANE AND HOIST CO. LTD., Reddish, Stockport, have opened a London office at Lincoln Chambers, Portsmouth-street, W.C.2, under the control of MR. K. A. BOWMAN.

THE BRITISH GENERAL ELECTRIC CO. (PTY.) LTD., have opened new premises, comprising offices, showrooms, stores, workshop and trade sales department, in Gale-street, Durban, South Africa.

GEORGE SALTER & CO., LTD., are shortly removing the manufacture of light springs from West Bromwich into a new plant in Spring-road, off Spon-lane, Smethwick, Staffordshire, in premises previously occupied by Archibald Kenrick & Sons, Ltd., founders.

AERO RESEARCH LTD., Duxford, Cambridge, inform us that their Northern Area office has been removed to larger premises at 409, Royal Exchange, Manchester, 2. (Telephone: Blackfriars 9445–6). It will continue under the management of MR. S. HOPWOOD, M.B.E.

THE SPENCER WIRE CO. LTD., Wakefield, Yorkshire, acquired, in January, 1955, the whole of the business and plant of the MIDLAND EXPANDED METAL CO. LTD., Tipton, Staffordshire. This has now been transferred to the head office and works, Thornes Wire Mills, Wakefield. MR. J. B. LIDDELL, a director of the company, is in charge of sales. The head sales office is situated at 53, Victoria-street, Westminster, London, S.W.1. (Telephone: ABBey 6373.)

The London office of ABELSON & CO. (ENGINEERS), LTD., Coventry road, Sheldon, Birmingham, 26, is to be moved, as from March 27, from 70, Victoria-street, S.W.1, to 60–62, Clapham-road, S.W.9. (Telephone: RELiance 5326.)

CONTRACTS

Air Liners. Lloyd Aero Colombiano, Bogota, Colombia, have ordered some Herald air liners from HANDLEY PAGE LTD., Cricklewood, London, N.W.2. Two prototypes are under construction at Reading and the first will fly this summer. Delivery for air-line service will commence in 1957. The four-engined Herald is a pressurised high-wing monoplane which can operate, if necessary from primitive airfields, under a wide range of climatic conditions. It carries up to 44 passengers and upwards of 4·75 tons of freight, at cruising speeds greater than 200 m.p.h.

Railway Rolling Stock. The British Transport Commission have placed orders for 207 new coaching vehicles and 670 ballast and sleeper wagons. The order for the carriages comprises 60 corridor third brake coaches, with the GLOUCESTER RAILWAY CARRIAGE AND WAGON CO. LTD., Gloucester; 95 corridor composite coaches, with the METROPOLITAN CAMMELL CARRIAGE AND WAGON CO. LTD., Birmingham, 8; 12 corridor third brake coaches with CHAS. ROBERTS & CO., LTD., Horbury Junction, Yorkshire and 40 gangwayed brake vans, with CRAVENS LTD., Darnall, Sheffield. Of the ballast and sleeper wagons, 252 have been ordered from the BUTTERLEY CO. LTD., Butterley, near Derby; 202 from the GLOUCESTER RAILWAY CARRIAGE AND WAGON CO. LTD., Gloucester; 116 from the CAMBRIAN WAGON AND ENGINEERING CO. LTD., Maindy, Cardiff; and 100 from the DERBYSHIRE CARRIAGE AND WAGON CO. LTD., New Whittington, Chesterfield.

Mast for Television and Sound Transmitting Station. The British Broadcasting Corporation have placed a contract with J. L. EVE CONSTRUCTION CO. LTD., 17 Hillside, London, S.W.19, for the design, supply and erection of a 560-ft. stayed mast for the Norwich television and very-high-frequency sound transmitting station The mast will support the television sound and vision aerials and also the aerials for the v.h.f. sound transmission. It is hoped to have the work completed so that the station can be ready for service about the middle of 1956.

Mail Steamer. The Union-Castle Mail Steamship Co., Ltd., have placed an order with HARLAND AND WOLFF Ltd., Belfast, for a Mail Steamer for the South African Service. She will be similar to the 28,700-ton S.S. Edinburgh Castle.

Television Equipment. Associated-Rediffusion Ltd., through their technical advisers, Central Rediffusion Services Ltd., have placed with MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex, a contract for the provision and planning of studio and outside-broadcast equipment. The initial order includes the complete installations for three three-camera studios, one two-camera studio and two complete three-camera television outside-broadcast vehicles. In addition, one set of master control switching and central apparatus and other equipment are to be supplied.

Air-Cooled Heat Exchangers. The Iraq Petroleum Co., Ltd., have placed a further large order with HEAD WRIGHTSON PROCESSES LTD., Teesdale House, 24-26, Baltic-street, London, E.C.1, for Fluor "Fin-Fan" air-cooled heat exchangers for cooling Diesel-engine jacket water. The coolers are to be installed at two pumping stations on the pipeline from the oil field at Kirkuk to the sea terminals on the Mediterranean.

Road Bridge. A contract for a "submersible" highway bridge over the Chambal River, near Agra, has been obtained by GAMMON INDIA LTD., Bombay. The bridge, which is to be 2,434 ft. in length, will have spans of up to 143 ft. long, and foundations 60 ft. below low-water level. The structure is designed to be submerged, during monsoon floods, to a depth of up to 27 ft. of water. These high floods, however, are stated to be infrequent and to be of brief duration.

Transatlantic Liner. The Cunard Steam Ship Co., Ltd., have placed an order with JOHN BROWN & CO. (CLYDEBANK), LTD., Clydebank Shipyard, near Glasgow, for a 22,000-ton steamer for the Canadian service. The vessel will be named the Sylvania and is due for completion in 1957. She will be similar to the recently-completed Saxonia, a twin-screw turbine steamer also built by John Brown & Co. (Clydebank), Ltd. The Saxonia has a length of 586 ft. 5 in., a breadth of 80 ft. 4 in., and a depth of 33 ft. Two other sister ships are in course of construction and each of the four vessels will have a service speed of from 18 to 20 knots, which will permit them to make the transatlantic passage to Montreal in 6 days, carrying some 1,000 passengers.

THE ROYAL SOCIETY

Annual Election of Fellows

At its meeting on March 17, the Royal Society elected into the Fellowship 25 persons, including:

PROFESSOR D. R. BATES, Professor of Mathematics, Queen's University, Belfast, for his contributions to theoretical atomic physics and its application to the interpretation of phenomena in the earth's atmosphere.

PROFESSOR A. H. COTTRELL, Professor of Physical Metallurgy, University of Birmingham, for his research work on the mechanical properties of metals.

PROFESSOR SAMUEL DEVONS, Professor of Physics, Imperial College, London, for his researches in nuclear physics, including the investigation of short-lived states of nuclei.

PROFESSOR K. C. DUNHAM, Professor of Geology, University of Durham, for his petrological researches and his work on the genesis of ore deposits and on the stratigraphy of the north of England.

DR. ALEXANDER FLECK, chairman, Imperial Chemical Industries Ltd., London, for his contributions to chemical technology and his pioneering work on the radioactive elements.

PROFESSOR W. R. HAWTHORNE, Professor of Thermodynamics, University of Cambridge, for his researches in the combination of thermodynamics and hydrodynamics on which the design of high-speed heat engines is based.

PROFESSOR R. W. JAMES, Professor of Physics, University of Cape Town, South Africa, for investigations of the structure of matter through the use of X-rays, and for his studies of thermal motions of atoms in crystals.

MR. J. W. LINNETT, lecturer and demonstrator in chemistry, University of Oxford, for his work on molecular structures and the physical chemistry of combustion and flame propagation.

PROFESSOR A. C. B. LOVELL, O.B.E., Professor of Radio Astronomy, University of Manchester, for his contributions to radio astronomy and his work on the detection and investigation of meteors by radio methods.

MR. R. A. LYTTLETON, lecturer in mathematics, University of Cambridge, for his original contributions to theoretical astronomy and astrophysics, and his mathematical researches on rotating liquid masses.

PROFESSOR A. G. WALKER, Profes sor of Pure Mathematics, University of Liverpool, for his work on foundations of relativity theory and important contributions to differential geometry.

* * *

I.MECH.E. COUNCIL ELECTIONS

The result of the ballot for elections to the Council of the Institution of Mechanical Engineers was announced at the meeting held on March 18. The new President is Mr. P. L. Jones, M.C., B.Sc., Wh.Ex., director of Swan, Hunter, and Wigham Richardson, Limited, Newcastle-upon-Tyne, and of Wallsend Slipway and Engineering Company, Limited, Wallsend-on-Tyne. The two vice-presidents are Mr. H. Desmond Carter, managing and engineering director of Crossley Brothers, Limited, Openshaw, Manchester, and Mr. G. Varley, M.Sc., chief engineer and consultant, Dodd Investments, Limited, Oldham.

The ordinary members of Council are: Mr. H. Norman G. Allen, M.A., joint managing director, W. H. Allen, Sons and Company, Limited, Queen's Engineering Works, Bedford; Mr. R. C. Bond, chief mechanical engineer, British Railways Central Staff, British Transport Commission; Dr. T. W. F. Brown, research director, Parsons and Marine Engineering Turbine Research and Development Association, Wallsend; Mr. G. B. R. Feilden, M.A., engineering director, Ruston and Hornsby Limited, Lincoln; Major-General W. A. Lord, C.B., C.B.E., M.Eng., director of mechanical engineering, War Office, and executive head of the Corps of Royal Electrical and Mechanical Engineers; and Dr. W. Ker Wilson, Wh.Ex., chief research engineer, de Havilland Engine Co., Ltd., Edgware.

The associate member elected to the Council is Mr. P. McGregor Ross, B.A., chief engineer, gas-turbine department, C. A. Parsons and Company, Limited, Newcastle-upon-Tyne.

HAND-WROUGHT CHAINS

A LITTLE-KNOWN INDUSTRY RECORDED FOR THE NEWCOMEN SOCIETY

The products of the chain trade are familiar enough in all branches of industry, but little is known generally about the trade itself. The manufacture of hand-wrought chains is concentrated mainly in the Black Country area in the Midlands, and the trade has always been small in relation to its industrial importance. Perhaps because of its small size it has never attracted the attention of writers in the past and what records do exist are few in number, and in some cases of doubtful authenticity.

Mr. W. K. V. Gale, in his paper "Hand-Wrought Chains," read at a meeting of the Newcomen Society on March 9, said that the trade grew on a highly individualistic basis, and had developed tools and techniques to suit itself. Changes were taking place, and much that was of interest would be lost unless some record of the trade were made now. The paper aimed, therefore, at setting down, in some detail, the trade practices, methods and techniques used in the manufacture of hand-wrought chains as it is carried on at present.

The speaker said that the history of the trade was obscure. When it became established in the Black Country was not known; why it should be so established was a much simpler question. It grew there because the area had, in the past, abundant supplies of high-grade wrought iron, coke breeze for the chainmakers' hearths, and a local population skilled in the hot-working of iron. So the trade came to the Black Country, and there it grew and flourished. For a century or more there have been very few changes, but in recent years new materials and methods have been developed, and their effect on the trade has been considerable.

MANUFACTURING METHODS

For the purposes of description, chainmaking can be divided into three groups, though chains themselves can be grouped into several different classes according to the use to which they are to be put. The manufacturing groups are: heavy chains and chain cables, medium chains and light chains. Heavy chains and chain cables (which are heavy chains with a cast-iron stud in each link) are always made by a team of three men. They range in size from about 1¼ in. to the largest size made, which may be 6 in. or more. Medium chains are in the range ⅜ in. to 1 in. and are made by a man working on his own, either in a factory or in a domestic workshop. Small chains are from about 12 s.w.g. (0·104 in.) to ⅜ in., and are, or were, usually the product of a woman domestic worker. These are the basic groups, and are generally adhered to quite closely, though there has been a certain amount of overlapping between one group and another in the past. Women, for example, sometimes made chains up to ⅞ in. in diameter, and men occasionally worked down to 4 s.w.g, (0·232 in.). Men also made, and still make, chains between 1 in. and 1¼ in. in diameter, assisted by a single striker, which places them in a group between the heavy and medium workers.

Chains were made to standards developed by trade usage long before specifications were introduced by any of the recognised standardising bodies, and several different types of chain are in normal production. The principal types are: chain cables and heavy chains, short-link, pitch or block, long-link, and twist. Chain cables have a central stud of cast iron which improves the flexibility of the cable, and provides a safeguard against link-side collapse under heavy load. Heavy chains are very similar, but have no stud. Short-link chain may be of any size and length. The links have a length of 4½ times and a width of 3¼ to 3½ times the diameter of the material in the link, the dimensions being taken overall. Short-link chains are the most common type, and are used in all situations where life or property may be at stake. Pitch or block chains are short-link chains with the links made to gauge so that they will fit the pockets of chain wheels. Long-link chains, which have a link length of six times and a width of 3½ times the material diameter, are neither so strong nor so flexible as short-link, and are used for less important duties. The link proportions are sometimes varied to suit a customer's requirements. Twist chains are basically of the long-link type, with each link twisted through 90 deg. so that the chain will lie flat. They were extensively used in the past for harness work.

TRADE CUSTOMS

The size of a chain is expressed as the diameter of the material in the link, and allowance has to be made for heat-scaling when the material is hot-worked. Some loss of diameter is inevitable, and the material has therefore to be oversize to ensure that the finished link is of the specified diameter. There are no fixed allowances, but as an example one cable manufacturer allows $\frac{1}{32}$ in. for bars up to 1$\frac{15}{16}$ in. in diameter, and $\frac{1}{64}$ in. over that size. Scaling allowance, like many other features of the trade, is largely determined by experience. In their working customs the chainmakers provide one of the last examples of the time-honoured "butty" or sub-contracting system. The chainmaker is employed by the firm and paid on a weight basis; if he wants assistants he employs and pays them himself, without reference to his employer. What wages he pays are the subject of agreement between the parties concerned, the firm having no interest in the matter. Each man or team of men starts work at about 5 a.m., and goes home when the day's quota is finished, which is usually about 11 a.m. or noon. This arrangement is the trade custom. No attempt to alter it has ever succeeded, and no reason has ever been discovered for it. A suggestion has been made that the early start is to enable the work to be finished before the hottest part of the day, but it is not acceptable, as the same hours are worked in the winter. No chainmaker was able to tell the speaker why the hours should be as they were: it is a tradition and it will remain as long as chains are made by hand.

The speaker went on to a detailed study of the tools and methods used by the workers in each group, heavy, medium and light, and gave details of the traditional names for the tools and equipment. Some fundamental differences were noted.

In the case of heavy chains and chain cables, for example, a team of three men is always employed, but chains up to 1$\frac{15}{16}$ in. in diameter are made by end welding, and chains from 1⅞ in. diameter upwards are side-welded. Links for the end welders are cut cold by shears, and scarfed and bent to link shape by the team, but the side-welders are supplied with links cut with scarfed ends and bent to link-shape by machines before they arrive at the hearth. Medium chainmakers, working singly, are also supplied with cut straight links, and do their own bending and scarfing to prepare the link for welding or "shutting," which they then carry out with a hand hammer. The finishing or "dollying" of the link is done with the treadle hammer or Oliver by the single-handed workers.

In the light-chain trade the woman domestic worker is supplied with rods in bundles about 8 or 10 ft. long, and cuts her own length for each link. The domestic trade, which has usages and trade names quite different from the other branches of chainmaking, has been the hardest hit by the introduction of machine-made chains, and only one or two domestic workers are still in business.

BOOK REVIEWS

Irrigation and Hydraulic Design. Vol. I: General Principles of Hydraulic Design. By SERGE LELIAVSKY. *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (126*s.*)

This book is difficult to classify. It is the first of a trilogy intended for practising irrigation engineers, but the spate of mathematics in the first chapter—including an exposition of elliptic integrals—is more likely to frighten away these rare birds. This would be a pity, for underlying much of the mathematical trimmings there is a wealth of sound theoretical and empirical information.

The first two chapters are taken up with the difficulties inherent in the construction of large-scale hydraulic works on a permeable bed. This problem has confronted engineers in Egypt and India for many years and is common to all the great alluvial basins. On a small scale similar circumstances sometimes arise in this country, often without being recognised. The author is particularly well qualified to write on this subject for he has had a distinguished career both on the hydro-electric works of the Dnieper and later as head of various technical departments of the irrigation and hydro-electric services of the Nile. The first chapter, of 200 pages, deals with the dangers attendant on the seepage of water under the structure; and the second deals with the scouring action of the water passing over the top. The dangers associated with seepage are uplift from hydraulic pressure under the structure and piping at the downstream end. The latter occurs when the force on the sand particles due to the hydraulic gradient overcomes their effective weight and the friction exerted by surrounding particles. Early estimates of uplift assumed that the seepage was confined to creep round the substructure perimeter and that the hydraulic gradient was constant and equal to the head across the work divided by the perimeter, including sheet piling. Critical values of these gradients were specified to prohibit piping.

Later work showed that the hydraulic gradient at the downstream end could rise locally to very high values and that the flow in a homogeneous subsoil followed laws analogous to those for inviscid flow, the potential surfaces of the latter corresponding to surfaces of equal piezometric pressure. This enabled the methods developed for solving potential flow problems to be used to calculate the subsoil flow network and pressures. More recently, potential flow solutions have receded in significance because of evidence that failure has sometimes occurred by "roofing" due to local settlement of the soil after construction and "backward erosion" from springs caused by inherent defects in the detailed geological structure. In modern structures the first type of failure can be guarded against by avoiding long stretches of horizontal flooring and the second by cut-offs, graded filters, weep holes, impervious blankets and the like. The risk of undermining is increased if large scour holes are allowed to develop close to the downstream end of the works. The means taken to reduce such scour is the main theme of the second chapter. When an apron forms the only protection, formulae for the length of the solid and pitched portions have been derived from a critical examination of existing works.

Nowadays, the barrage designer has the choice of a large number of anti-scour devices, most of which take advantage of the property of the standing wave to dissipate energy. For the most part these have been developed from experiments made on small-scale models. Such experiments can give a valuable guide but cannot yet be relied upon for quantitative precision regarding scour-hole dimensions because the conditions necessary for reproduction of the bed movement are still uncertain. The author rightly complains that despite the tremendous amount of experimentation that has been done it has "failed to supply the material required for a constructive general theory of scour prevention." In justice to those using models, however, it should be stated that far too often in the past they have been pressed to provide specific answers to *ad hoc* problems and have not had the time (and in some cases the inclination) to make the more elaborate investigations required for a general theory.

The last chapter has no direct connection with the preceding ones. The first part is concerned with uniform flow and a good deal of space is devoted to the early ideas on the subject and historical friction formulae; it also includes an excellent exposition of the more recent work of Prandtl and his collaborators. The second part is concerned with steady non-uniform flow and backwater wave analysis. This topic is treated in great detail, some nine different methods of solution being described with worked examples and complete numerical tables and charts for their application. Unfortunately, the author gives no clue as to the relative time consumed by the various methods, some of which seem to be of interest only to the connoisseur.

Two major omissions of the book are, first, a discussion of the problems associated with the movement of solid material by water; second, the fundamental problem of the rise of the water table due to irrigation and the consequent evaporation and salting. The first is a constant source of embarrassment to irrigation engineers concerned with the silting of reservoirs and above barrages, and with the general problems of silt exclusion from irrigation canals as well as those of scour at bends and retrogression below barrages. The second is already a menace in certain canal systems in the Punjab and is likely to loom larger in the future.

There are several minor misconceptions and unusual terms. Examples of the first kind are Fig. 210, which shows a progressive oscillatory wave with a flat crest and peaky trough, and the remarks on page 276 which appear to anticipate some relationship between surface waves and bed movement. Examples of the second kind are the use of "streamline" to describe flow at low Reynolds numbers, "submerged wave" to describe submerged flow, and "fluent" to describe subcritical flow. In addition, references to the intuition and feelings of experienced designers are somewhat disconcerting in a book designed to set the subject on a logical foundation.

The book is well illustrated although the consecutive numbering for both diagrams and plates (the latter being occasionally well removed from the relevant text) is a little confusing in places. Apart from this, the book is plentifully referenced, attractively set out and eminently readable, and there are few typographical errors. Both author and publisher are to be congratulated.

Radio and Television Engineers' Reference Book. Edited by E. MOLLOY. *George Newnes, Limited, Tower House, Southampton-street, London, W.C.2.* (70*s.*)

The size of this reference book, which runs to over 1,600 pages, is some indication of the growth of knowledge in the radio and allied fields. The title is a rather conservative one, for, in addition to commercial broadcasting and receiving equipment, there are sections devoted to such subjects as electron optics, wave guides, and navigational radar. Various types of recording equipment are also described.

The book, which is a first edition, is written in a manner suitable for use by the practical layman or the professional. The 45 sections into which it is divided have been written by 36 contributors, of whom brief biographies are given. Credit is due to the editor for the orderly manner in which the matter is arranged and for the comprehensive index. The illustrations are plentiful and clear.

It is difficult in reviewing a book of this nature to avoid giving merely a string of chapter headings, but although this would give an idea of the field covered, it would not indicate the detail which is included. For, in addition to such a simple one as "Resistors"—which describes the characteristics of the types available—there are others such as "Television receiver design" which is divided into no less than 62 sub-sections. But, in general, it may be said that not only are complete units considered from both the design and the maintenance angles, but also the characteristics of components—valves, resistors, capacitors, loudspeakers—are described in detail and their methods of use outlined. At the beginning of the book is a section, of 145 pages, devoted to formulæ and calculations and this covers almost all the problems met with in design, including such indirect but necessary points as cooling and ventilation. The volume concludes with lists of units and symbols in current use.

The Recruitment and Training of Men Intended for Management Positions. *British Institute of Management, 8 Hill-street, London, W.1.* (5*s.*)

There has been since the war a remarkable growth of interest in training for management. Many large, and some small, firms have instituted more or less elaborate schemes for the purpose and the publication by the British Institute of Management of this pamphlet, describing the methods employed by a number of large companies, is therefore of particular value. The companies selected cover a wide variety of industries, both heavy and light, and one nationalised industry is included. Most of the companies employ more than 5,000 persons.

The pamphlet does not deal with the content of training courses, but with the methods of selection and personal development of the potential manager and the administration of a training scheme. Selection is obviously of supreme importance. An interesting appendix gives figures, prepared by the University Appointments Board, showing that, out of 20,000 graduates turned out annually, 6,500 go into technical and scientific posts in industry and 1,000 as trainees into executive posts in industry or commerce. Out of 8,000 Arts graduates only 1,000 enter industry for management training. There are considerable differences in the methods employed by the companies for selection purposes—group selection, individual interviewing and panel interviewing all being employed. The difficulty of finding one individual capable of making a correct assessment of an applicant's character and personality is emphasised. A number of useful appendices describe the selection methods of particular companies.

One of the most important aspects of management training is induction: easing the young recruit into the organisation in order both to ensure that he understands what he will be expected to do and to establish satisfactory relationships with existing members of the management and supervisory staff. Equally important is the follow-up to ensure that the trainee is gaining full benefit from the training course and to disclose the problem cases, to which a short separate section is devoted. These are the people who, after acceptance as trainees, later reveal personal qualities unfavourable to their development as potential managers, such as the "impatient thruster," the "plodder," the "swelled head" and the "frustrated intellectual." There is also the problem of the unsympathetic manager or supervisor, which is dealt with differently by the various companies. On the whole, the view is expressed that the trainees should not be sheltered but should learn how to get on with all sorts and conditions of men.

Among the methods of training considered is the use of the trainee in the role of personal assistant to a senior manager. The general conclusion is against this method for the initial training period, and an interesting appendix summarises its advantages and disadvantages. The disadvantages outnumber the advantages by seven to four.

The information so briefly summarised in this admirable pamphlet will be of the greatest value to any organisation contemplating the introduction of formal methods of management selection and training.

BOOKS RECEIVED

Some of the books noticed in the Books Received column are selected for extended review in later issues of ENGINEERING.

Theory of Machines through Worked Examples. By G. H. RYDER. *Cleaver-Hume Press, Limited, 31 Wright's-lane, Kensington, London, W.8.* (18*s.* 6*d.*)

The complete solutions to 160 problems are presented in this book, which has been prepared on a basis of the requirements for higher national certificates, university degrees, and examinations of the professional engineering institutions. Each chapter begins with a summary of principles, formulae and methods, and 100 additional graded problems are provided as exercises for the student. The subjects covered include linkages, gear trains, cams, friction clutches, belts, brakes, inertia, and vibrations, and an index is provided. Mr. Ryder, who was formerly senior lecturer in the Mechanical Engineering Department of the College of Technology, Birmingham, is now principal lecturer at the Royal Military College of Science.

The Federation of Rhodesia and Nyasaland. Overseas Economic Survey. By H. W. WOODRUFF. *H.M. Stationery Office, Kingsway, London, W.C.2.* (5*s.*)

This survey outlines the changes that may follow the drawing together of formerly separate territories into a federation. Subjects covered include the economy of the Federation, its products, imports, agriculture and finances. Details are given of the regulations governing trade, and of the competition likely to be met. One section deals with the way in which the new African wage-earner spends his money.

The Recruitment and Training of Men Intended for Management Positions. *British Institute of Management, 8 Hill-street, London, W.1.* (5*s.*) (Reviewed on page 365.)

Nicaragua. Overseas Economic Survey. By HUBERT EVANS. *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.* 6*d.*)

The transformation in the pattern of British trade with Nicaragua is explained in detail by Mr. Hubert Evans, H.M. Ambassador and Consul-General at Managua, in this survey. Significant points are the decline in United Kingdom exports of cotton and jute goods, and the increase in exports of motor cars, motor cycles and cycles.

Private United States Investment in Europe and the Overseas Territories. *Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris, 16e.* (400 francs); and *H.M. Stationery Office, Kingsway, London, W.C.2.* (8*s.*)

As part of an attempt to create conditions more conducive to United States private investment overseas, the O.E.E.C. organised a meeting in 1954 between European experts and American business men. This report gives particulars of the statutory regulations and administrative provisions that apply to such investment, and recommends various measures likely to encourage it. An appendix to the report describes the provisions applying in each country regarding the permits required, the effect of exchange controls on the transfer of capital and income, the constitution and operation of foreign-owned firms, and guarantees given against expropriation or tax discrimination.

Theory of Structures. By H. W. COULTAS. Fourth edition. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2.* (25*s.*)

This text-book on the fundamental principles of the theory of structures is designed to fulfil the requirements of degree and institution examinations in that subject. In this fourth edition a chapter on prestressed concrete design has been added, and among other revisions are up-to-date references to journals in which new theories and methods are presented. Mr. Coultas, who is a lecturer in the Civil Engineering Department of the University of Birmingham, has included in his book numerous examples with answers, a summary of formulae and an index.

The Sheet Metal Worker. Choice of Careers Series No. 58, Central Youth Employment Executive. *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.* 3*d.*)

One of a series of publications describing primarily for boys and girls the main features of various professions, industries, crafts and services, this booklet deals with the sheet-metal worker. In it are outlined the nature of his work, his prospects and conditions of employment, and the training he must undergo; in addition many of the processes involved in his craft are represented in illustrations. Not only the cutting and shaping of sheet metal, but also such jointing techniques as soldering, brazing, welding and riveting are briefly summarised. Finally reference is made to openings in industry, the industrial Civil Service and in H.M. Forces for young men wishing to take up an apprenticeship in this field.

Engineering Draughtsman. Choice of Careers Series No. 60, Central Youth Employment Executive. *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.*)

In the same series as the booklet described in the preceding paragraph is this publication outlining the work of the draughtsman. It covers draughtsmanship in various branches of engineering and provides an introduction to the subjects of design, detailing and development. Training, prospects and opportunities are considered, as well as the qualities required by young people proposing to enter the drawing office as a career.

The Oil Engine and Gas Turbine World Directory of Manufacturers. Compiled by the staff of *The Oil Engine and Gas Turbine. Temple Press, Limited, Bowling Green-lane, London, E.C.1.* (2*s.* 6*d.*)

In the first section of this booklet manufacturers of oil engines are listed together with details of engines made and the corresponding ranges of brake horsepower. The second section is devoted to gas-turbine manufacturers, and brief descriptions of the designs associated with each firm are given, with information regarding output and types of installation. Both sections are arranged in alphabetical order of countries, with the exception of Great Britain which appears first in each case, but only the oil-engine section includes Soviet Russia and the other Communist-controlled countries. Full addresses accompany each firm named.

Engineering in Agriculture. By P. H. SOUTHWELL. Published in association with "Farm Mechanization," by *Temple Press, Limited, Bowling Green-lane, London, E.C.1.* (30*s.*)

With increasing use of engineering in agriculture, farmers are at an advantage if they understand engineering principles. This book explains principles of civil, mechanical and electrical engineering particularly as they affect the farmer; it includes chapters on heat engines, mechanisms, stresses and structures, properties and use of materials, electricity, hydraulics, earthworks and surveying, and drawing and design. It is intended to be read by farmers and students of agriculture and agricultural engineering; they need have no previous technical knowledge.

Safety Code for Industrial Power Trucks. *Industrial Truck Manufacturers' Association, 94/98 Petty France, London, S.W.1.* (2*s.* 6*d.*)

The hazards involved in operating industrial power trucks, and the ways in which both designer and user can help to eliminate accidents provide the subject matter of this booklet. Its six sections are: construction and design considerations, minimum capacity ratings, operation of equipment, a safety code for straddle carriers, terms and definitions, and a table of safety regulations for operators. In this last section, humorous illustrations lend force to the text.

The Exporter's Year Book, 1955. *The "Syren and Shipping," Limited, 26-28 Billiter-street, London, E.C.3.* (40*s.*)

This is a reference book of the documents required in international trade. All countries are included and the documents required by the various customs departments of the world are set out. Details are given of Consular invoices, commercial invoices, bills of lading, the various certificates relating to specific products and to goods entitled to tariff preferences, etc. Other information given includes population figures, details of Commonwealth and foreign representation in the U.K., overseas banks and chambers of commerce, currencies, weights and measures, and brief reports concerning packing, commercial travellers, samples, trade marks and patents.

Further Studies in the Compaction of Soil and the Performance of Compaction Plant. By W. A. LEWIS. Road Research Technical Paper No. 33. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.2.* (3*s.*)

The results of tests by the Road Research Laboratory on a wide range of compacting machines used in Great Britain are given in this paper, which deals with work carried out since the publication of Technical Paper No. 17. Soils chosen for the investigation as representing most British types were: a heavy clay, a silty clay, a sandy clay, and sand and a gravel-sand clay (hoggin). Fourteen kinds of compaction plant were studied including track-laying tractors, although towing compaction plant. The types used in the tests were smooth-wheeled rollers, a pneumatic-tyred roller, sheepsfoot rollers, rammers, vibrating smooth-wheeled rollers and plate vibrators. The selection of moisture content at which to compact, and the compaction necessary in road embankments are other subjects covered, and a new method of specifying the state of compaction required in earthworks in terms of a maximum percentage of air voids in the soil is also suggested. The booklet includes tables, graphs, diagrams and half-tone prints, and lists references made in the text.

Marketing Safety Code: Part II of the "Model Code of Safety Practice in the Petroleum Industry." *The Institute of Petroleum, Manson House, 26 Portland-place, London, W.1.* (12*s* 6*d.*; 10*s.* 6*d.* to members.)

This Code gives guidance on the layout, maintenance, equipment and operation of the installations and depots necessary for the safe marketing of petroleum products. It is issued in loose-leaf form to fit into the standard binder which will hold four parts of complete Codes. A glossary of terms used in the petroleum industry is included.

Failure of a Large Welded Oil Storage Tank. *The National Boiler and General Insurance Company, Limited, National Buildings, St. Mary's Parsonage, Manchester, 3.* (No price given.)

During a static water test at the Esso petroleum installation at Fawley, Hampshire, a large oil-storage tank failed. The present report, made by the National Boiler and General Insurance Company, Limited, is in two parts. The first constitutes a preliminary survey of the tank and its sudden failure, while, in the second resport, as many details as possible of the design, construction and manufacture of the tank, together with the particulars of the tests made on the material, have been collated and recorded.

Manual on Industrial Water. Second Printing with New and Revised Methods, 1954. A.S.T.M. Special Technical Publication No. 148-A. *American Society for Testing Materials, 1916 Race-street, Philadelphia 3, Pennsylvania, U.S.A.* (5 dols.)

This manual is intended as an authoritative reference source of information for executives and plant designers, analysts, engineers, and consultants. While the general discussion is essentially identical to the first printing, eleven new test methods, eight revisions of existing methods, a complete table of contents, and a detailed index have been incorporated.

Table of Salvo Kill Probabilities for Square Targets. U.S. National Bureau of Standards Applied Mathematics, Series 44. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (30 cents.)

This table was prepared by the National Bureau of Standards Institute for Numerical Analysis, Los Angeles, with the support of the Flight Research Laboratory, Air Research and Development Command, United States Air Force. However, it should be useful to other organisations engaged on operation analysis, strategic planning, engineering, and field-test activities, as well as missile-development programmes.

The Determination of Uranium in Uranium Concentrates using Ethyl Acetate. By R. J. GUEST and J. B. ZIMMERMAN. Technical Paper No. 8. *Department of Mines and Technical Surveys, Mines Branch, Ottawa, Canada.* (25 cents.)

In this paper is described a method for the determination of uranium in high-grade uranium material. Uranium is separated from contaminants by means of an ethyl-acetate extraction process using aluminium nitrate as a salting agent, and is then determined colorimetrically by the sodium-hydroxide/hydrogen-peroxide method. The procedure is claimed to be accurate, rapid and easily adaptable to routine work.

Tables of the Error Function and Its Derivative. U.S. National Bureau of Standards Applied Mathematics Series 41. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (3·25 dols.)

This volume is a re-issue of *Tables of Probability Functions*, vol. I, published in 1941 and known as Mathematical Table 8. The companion volume, *Tables of Probability Functions*, vol. II, has already been issued as Applied Mathematics Series 23, with the title *Tables of Normal Probability Functions*. The tables in the present volume extend the range of the existing tables and provide a smaller tabular interval. Provision has also been made to facilitate interpolation by the user of the tables, both direct and inverse.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Stethoscope. MURCHIE TRADING CO., LTD., 11 Kings-road, Sloane-square, London, S.W.3. The "Airsonic" industrial stethoscope for fault tracing in vibrating or moving parts; a variety of probes makes it possible to investigate faults in many different forms of machinery. The "Airsonic" was a subject for the B.B.C.'s television programme *Science Survey* recently.

Improving Productivity. DUNLOP RUBBER CO. LTD., St. James's House, St. James's-street, London, S.W.1. Description of the methods employed by the company to improve productivity at their tennis-racket factory at Waltham Abbey. Points mentioned: cutting veneers, glueing, multiple drilling, lacquering and stringing. Booklet also shows examples of 17th-century techniques.

Static Magnetic Comparators. NEVELIN ELECTRIC CO. LTD., Purley-way, Croydon, Surrey. Magnetic amplifiers for automatic control of output voltage of grid controlled mercury-arc rectifiers; no thermionic tubes or moving parts. Illustrated leaflet.

Auxiliary Relays. A. REYROLLE & CO. LTD., Hebburn, Co. Durham. Auxiliary relays for repeat contactors and other purposes. Sixteen types listed, contact capacity up to 1,500 VA. Leaflet No. 1258.

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BRITISH STANDARDS

The following publications have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2 Park-street, London, W.1, at the price given after each title.

Square-Nut Spanners (Post Office Type). (2*s.* post free.)

The square-nut spanners covered by the newly-issued B.S. 2575 have the general appearance of the heavier-looking regular-head type specified in B.S. 192, which deals with open-ended spanners. Their proportions and dimensions, however, are slightly different and the only range of sizes for which they are intended is that of the square nuts fitted to the old-style Whitworth bolts. These are the spanners used by the Post Office authorities, electricity administrations and other bodies on their outdoor reticulation equipment, such as telegraph poles. The nuts are subject to varying weather conditions and for this reason the spanners must be robust. The type adopted in the new specification is that which has been found most suitable.

Forged Steel Pipe Fittings (screwed with A.P.I. thread, for the Petroleum Industry). (3*s.* 6*d.*, post free.)

A new specification B.S. 2561, constitutes a further British Standard in the series covering steel fittings for the petroleum industry. It applies to forged carbon and alloy-steel screwed fittings for the petroleum industry, for assembly with pipes screwed in accordance with the American Petroleum Institute's specification 5L, covering line pipe. The new standard provides for 90 deg. and 45 deg. elbows, T-pieces, crosses, laterals, couplings, half-couplings, reducing couplings, caps, plugs of various kinds, and hexagonal bushings. The range of sizes is from ⅛ in. to 6 in., and the range of ratings from 600 lb. to 1,500 lb. per square inch "within plot limits." This may be defined as areas in which operating and safety considerations have determined the limiting stress values upon which the pressure-temperature ratings are based. Dimensions, tolerances and materials are specified in the new publication and stipulations as to marking laid down.

Wrought Steels (in the form of bars, billets and forgings.) (12*s.* 6*d.*, post free.)

First published in July, 1941, a third revision of B.S. 970 dealing with wrought steels in the form of bars, billets and forgings up to 6 in. ruling section, for motor-car and general engineering purposes, has now been issued. This sets out the chemical compositions of En steels which are normally supplied in the form of plate, sheet, strip and wire. Also included are the case-hardening steels of the En 350 and En 360 series. Other features which will enhance the usefulness of the Standard are: the coverage of Service requirements in so far as they are compatible with those of industry as a whole; an improved layout and a revised arrangement of the contents. A German translation of the specification is to be issued shortly.

The Engineering Outlook—11

MOTOR VEHICLES

AN EXPANSION IN OUTPUT OF LOW-PRICE CARS?

The year 1954 may well go on record as the beginning of an era of radical and profound change in the industrial make-up of Britain, and particularly in the pattern of British engineering. The challenge to the established industrial order has come from industries manufacturing consumer goods, such as electrical household appliances and cars. Both the light electrical and the motor-vehicle industries plan considerable expansion of output during the next five years. In both cases the plans are based on the assumption that the standard of living in this country will continue to rise and bring about in its ascent a very large popular-based demand for their products.

Two pioneers of mass-production engineering in Britain, Mr. Harry Ferguson and Sir Charles Colston, have stated their belief in a vast potential market for cars and new types of electrical appliances which can be produced cheaply enough to be given a place in wage-earners' budgets, and they are preparing to meet this popular demand (ENGINEERING, vol. 178, page 66, 1954, and vol. 179, page 291, 1955). There is much evidence, in this and other countries, that they are on the right track: the success of the Ford "Popular," the Volkswagen and of the baby Renault, Citroen and Fiat shows that, once the motoring costs of a particular car are sufficiently low, sales shoot up to a level limited only by the capacity to produce.

It should perhaps be said at this stage that the actual price of a car appears to have less influence on its sales than its running costs, though price is obviously of considerable importance if cars are purchased out of income through hire-purchase arrangements, as is the general practice in the United States. Likewise, in this country one would expect the price of cars to become increasingly important as sales of new cars are made to people planning to use them mainly for pleasure.

REDUCING PRODUCTION COSTS

The arguments of those who advocate a major expansion in car output are based on the belief that considerable economies in production costs can still be derived from an increase in the scale of output of popular models. This, they consider, will be particularly the case if the demand for standard components is large enough to warrant the building of specially designed modern factories equipped with machines suitable for automatic control, thus making possible major reductions in labour costs. It is argued that, given sufficient output, the cost per pound of British-made cars can be lowered to compete with that of any in the world, including American. Obviously this must be so since labour costs in this country are lower and the cost of raw materials not appreciably higher. It can be claimed, however, that it costs more per pound to produce cars with a low fuel consumption and that commercially there is a need for variety which is not present in the United States.

Nevertheless, the very extensive re-equipment of all major producers since the war, and the re-equipment of the industries supplying materials and components which is now in progress should considerably improve the competitive position of British cars compared with that existing before the war, provided the scale is adequate—say, 750 to 1,500 cars a day of one basic model. There is no magic in these figures—it could be substantially less if the major assemblers were willing to accept standard components—but it would be unrealistic to assume that progress towards inter-industry standardisation can be quickened sufficiently to make a major impact on costs.

At present, the cheapest British cars are competitive with any produced on the Continent—the Ford Popular retails at Fr. 46,000 in Belgium, compared with Fr. 57,000 for the Volkswagen, although the projected increases in output of the latter to some 1,500 cars a day should make them relatively cheaper and so lead to higher exports. There are few doubts in the industry that export markets which absorbed 366,000 cars and chassis last year, will absorb half a million by 1960.

The decision taken by General Motors and Ford to expand capacity in this country suggests that both companies believe this to be true and that they largely discount the possibility of a serious increase in the export of American-made cars—partly because of their relatively high running costs and partly because of the likelihood of a semi-permanent world shortage of dollars. Although the currency consideration was probably the main reason which led American companies to increase the car output of their subsidiaries in this country—and also in Germany—there is little doubt of the importance of low running costs.

TAXATION AND THE SMALL CAR

Immediately after the war nearly all British manufacturers were agreed that a medium-size car was the post-war ideal, and they succeeded in securing a flat rate of car tax in place of the horse-power tax to make this development

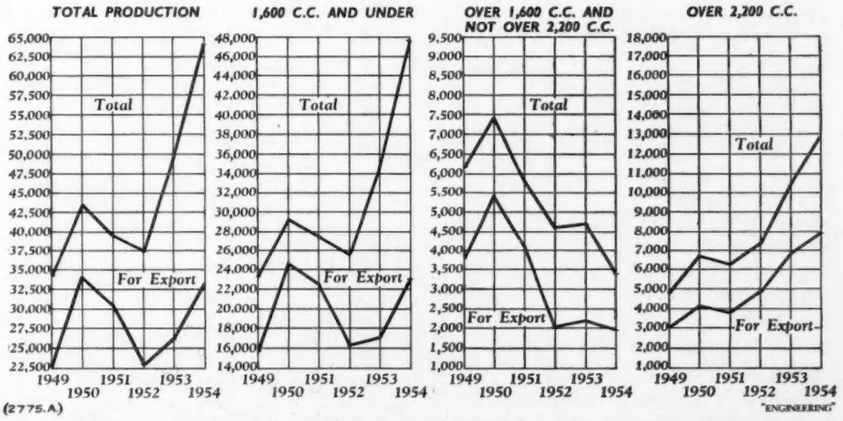

Fig. 1 Output of the principal sizes of motor car in 1954. During the year car production rose by nearly 30 per cent. and in particular there was a considerable increase in the output of cars over 2,200-c.c. capacity. Production is given in monthly averages for cars and chassis.

possible. All large companies now make small cars with the exception of Vauxhall Motors, who have never made one. The main reason for the return to the small car is the very high incidence of taxation on the cost of motoring in this country.

High taxation is in effect the major obstacle to the realisation of the industry's expansion plans. The high cost of motoring could prevent the industry from achieving the widely based home sales which they consider essential if they are to increase output sufficiently to cut production costs to a level where they are in an unassailable competitive position in world markets.

Another obstacle, the alleged preference in Commonwealth and other overseas markets (where the incidence of taxation is less) for larger and more powerful cars than can be afforded in this country, has been shown to be much less formidable than had been feared by the export success of small cars. During the three years 1952 to 1954, the number of cars and chassis up to 1,600 c.c. (most of them in the 1,000 to 1,200 c.c. category) has accounted for nearly 70 per cent. of total exports and for an even higher proportion of the exports of Germany, France and other Continental manufacturers.

The vexed question of taxation cannot be shelved for very much longer: purchase tax adds 50 per cent. to the ex-works costs and the petrol tax stands at 150 per cent. of the untaxed selling price, compared with 28 per cent. in the United States, 93 per cent. in Germany and over 200 per cent. in France and Italy. At the current rate of tax, every penny per gallon on motor spirit brings in £7·6 million revenue.

A broadsheet published by P.E.P.* last month suggests that an increase in consumption might follow a decrease in tax, although the increase in consumption would probably be confined to the private sector of motoring.

"The number of current vehicle licences (excluding motor cycles) in Great Britain is rather over four million, of which three million are private cars. By no means all of these will be used for private motoring. Some will be owned by business houses and local authorities which do not permit private use of their vehicles. A substantial proportion of the others will be used mainly for business. Purely in order to arrive at some estimate of magnitude it might reasonably be assumed that private—as distinct from business—motoring takes about two and a quarter million of these cars an average of 5,000 to 6,000 miles a year at twenty-seven m.p.g. That is to say each motorist who does any private driving at all uses about four gallons of petrol a week, and in the aggregate the total private motoring consumption of petrol amounts to 500 million gallons per year, or about 29 per cent. of the total petrol consumption of all vehicles. If the assumption is correct that the most elastic section of the demand for petrol is for private motoring, and that in the remaining sectors demand is relatively stable, it will be seen that to maintain total revenue a slight reduction in price must be accompanied by a very substantial increase in private consumption. Although there would be some increase, only practical experience will produce the answer as to the magnitude of the increase."

Whatever the Chancellor of the Exchequer feels about the likelihood of recouping through increased consumption any tax deductions he might be able to concede there is little doubt that some price adjustment will be necessary if the oil companies are to succeed in disposing of the motor spirit they must produce with existing plant in order to meet the fast rising demand (mainly determined by the tax position) for Diesel oil. The oil companies can therefore be expected to press the Chancellor to reduce the petrol tax and if he does not, or does so insufficiently to obtain the desired effect, they must at some not too distant time themselves alter their price policy, either to stimulate demand for motor spirit or to reduce demand for Diesel oil. It would seem therefore that motorists might expect some tax relief and that the car manufacturers will be at least a few steps nearer a "popular" private-car market than they have been so far.

* "Fuel for Twenty Years," P.E.P. (Political and Economic Planning), February 1955.

MORE CARS FOR THE HOME MARKET?

The arguments against a major increase in the sale of cars on the home market are of quite another kind. Can the country afford it? What substance is there in the argument that a large home market is essential to large export sales? Here the general economic situation suggests that, quite clearly, the country cannot afford—either in the form of industrial or private investment—more than is being spent at present (in fact rather less) unless what is spent on increasing capacity obtains a commensurate return from export sales and unless increases in export sales match increases in home sales.

Stated as simply as this the case against the motor industry is a formidable one; current plans add up to an increase in capacity from the 1954 output of just over 1 million vehicles to 1½ million in 1960; of the increase at least 350,000 will be cars. Exports are expected to rise by less than 150,000; home sales by twice that amount. But it may well be that exports could not be increased, or even maintained at their present level without the 50 per cent. expansion in capacity that has been planned. Volkswagen, Fiat, Renault, Opel and others will be increasing their own capacity with fewer obstacles in their own home market than their British competitors, and if the latter do not move forward they may well be left behind.

At the same time it is fairly clear that any increase in the home demand for new cars must largely come from private motorists and can therefore be classed as a luxury. Increased demand from industry and commerce cannot be expected greatly to exceed the rate of the country's industrial expansion—at the most 3 per cent. per annum. Assuming the bulk of demand, say 80 per cent., in 1954 was from motorists who used their cars mainly for business (or from business concerns), this type of demand in 1960 would total about 350,000 cars, leaving 300,000 to 400,000 for sale to private motorists. At an average price estimated at £400 per car (excluding purchase tax) the total investment in private motoring would, at current prices, have reached a minimum of £120 million a year by 1960, and total investment in cars, including business cars, would be £300 million.

Another argument that has been put forward, and was discussed in ENGINEERING on January 28 (page 100), is that the capital investment required to secure a 50 per cent. increase in road-vehicle output is too large to be afforded at the present time. This is especially true if resulting expansions in the output of materials and components are taken into account—such as additional sheet-steel capacity—and also the provision of site facilities such as sewerage, electric power, roads, sidings, etc., together with the inevitable increase in expenditure on roads, parking facilities, and garages. Such requisites would become necessary if the car population (already the densest in the world with 19 cars per road mile) were increased to 5 million or more, as could easily be the case if the industry's sales to the home market are realised. The total capital investment required is probably of the order of £700 million over the period, or £140 million a year, which is roughly one-third of the total net investment in fixed capital (excluding housing) in 1953.

LABOUR AND MACHINE TOOLS

The third major argument against the projected expansions is that they will require labour and machines which are not available. The lack of concern in motor-vehicle circles suggests that manufacturers are confident they will get all the labour they need from other industries, because they pay a much higher rate than most. To some, and particularly those affected, this is objectionable but it has long been the policy of the Government that labour should be encouraged to move to industries that have a high export potential and a high rate of productivity.

The supply of machine tools, most of them specialised, is unlikely to be very easy, particularly since the vehicle manufacturers have tended to delay their orders—on the ground that they could not be made specific until their expansion plans were settled (and this will probably mean lengthy delivery delays). The growth of such a machine-minded industry, however, is likely to be so great a boon to the machine-tool industry that few difficulties will be allowed to stand in their way.

Such is the background against which the industry is developing. It is highly competitive and there may therefore be some wastage before the large companies achieve their stated objectives. The most telling argument in its favour is that to put this country on the map as a mass-producer of cars would considerably

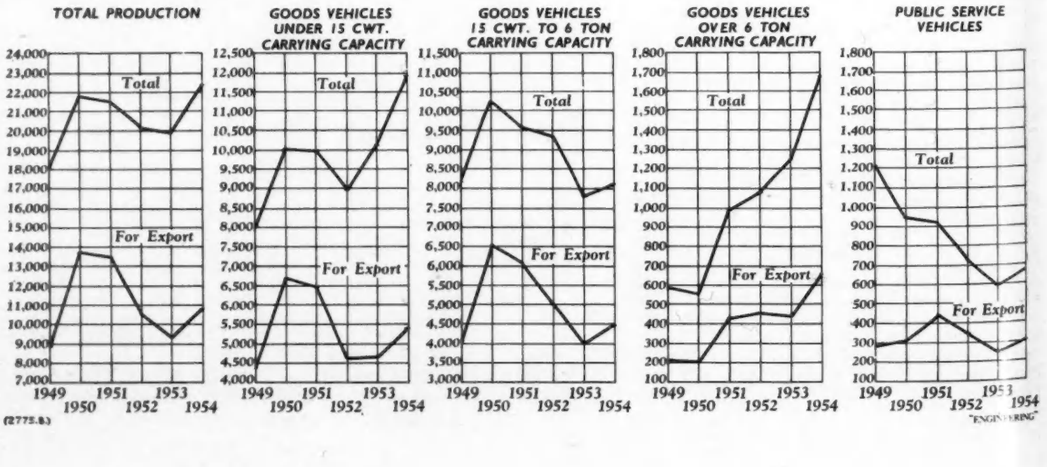

Fig. 2 The increase in production of commercial vehicles during 1954 (shown here in monthly averages) was smaller than that for cars, although the output of vehicles over 6 tons rose substantially. Exports of trucks of this kind were more than three times as high as in 1950.

TABLE.—United Kingdom : Exports of New Vehicles, Chassis and Parts (Value : £1,000)

—	Cars		Commercial vehicles		Total	
	1953	1954	1953	1954	1953	1954
Complete vehicles and chassis—						
Union of South Africa	5,903	5,162	4,464	5,283	10,637	10,445
Southern Rhodesia	1,938	1,882	1,169	1,367	3,107	3,249
Australia	15,758	24,307	7,440	10,358	23,198	34,665
New Zealand	6,855	12,768	2,483	3,957	9,338	16,725
Canada	10,587	5,738	745	304	11,332	6,042
Other Commonwealth countries	15,249	13,630	18,750	19,169	33,999	32,799
Irish Republic	3,092	4,931	1,262	2,130	4,354	7,061
Sweden	7,338	12,699	857	1,125	8,195	13,824
Denmark	3,704	3,904	2,382	2,464	6,086	6,368
Netherlands	2,923	3,680	1,722	1,954	4,645	5,634
Belgium	3,795	4,058	2,736	1,895	6,531	5,953
United States of America	11,701	11,165	203	92	11,904	11,257
Other foreign countries	15,066	14,595	17,921	17,958	32,987	32,553
Total	103,909	118,519	62,134	68,056	166,043	186,575
Parts	—	—	—	—	45,194	51,102
Grand Total	—	—	—	—	211,237	237,677

enhance its chances of economic viability in a highly competitive world.

COMMONWEALTH AND CONTINENTAL DEMAND

British cars could win over their Continental rivals a price advantage which would open up export markets to an extent unsuspected by the industry itself. Further, there is little doubt that marginal demand in Commonwealth and other markets exists to be tapped by cheaper cars.

There is much evidence that demand for cars throughout the world is highly elastic and that reductions in prices and motoring costs therefore tend to produce a much greater than proportional increase in demand. The difficulties attendant on allowing the industry to grow, so swelling home consumption and making heavy calls on the capital, labour and machine-tool resources of the country, are major ones, but it may be preferable to accept these than take the risks involved in thwarting its growth by taxation or physical restrictions.

Several of the country's staple industries are losing ground in overseas markets, and increasingly the burden of earning foreign exchange is falling on the " growth " industries, among which the motor-vehicle industry is a leader. Change is always painful, and very often wasteful, but little is to be gained by avoiding this type of waste since the penalty is stagnation.

Output of the main sizes of cars and commercial vehicles is shown in Figs. 1 and 2. It will be seen that car output increased by nearly 30 per cent. during 1954, although exports had not quite recovered to the level achieved in 1950 when they accounted for 78 per cent. of total production. One feature of the car production figures is the large increase in the output of cars over 2,200 c.c. and the very high proportion of exports (61 per cent.) in this category. Output of this type of car—dominated by the Jaguar—has nearly doubled since 1950.

COMMERCIAL VEHICLES

Production of commercial vehicles increased by a much smaller margin—12 per cent.—and exports were still over one-fifth below the 1950 level. The only substantial increase recorded in 1954, was in the output of vehicles over 6 tons, which rose to over 20,000—by 35 per cent. Exports of this type of vehicle, comprising 7 to 8 ton load capacity trucks of light construction such as the Bedford, Commer or Dodge, as well as trucks of heavy construction such as the Leyland, A.E.C., Foden, etc., were over three times as high as in 1950.

Exports of motor vehicles for the past two years are shown in the accompanying table. It will be seen that last year over two-thirds of total vehicle exports went to 11 principal markets, of which Australia took 18·6 per cent., New Zealand 8·9 per cent. and Sweden 7·4 per cent. The heavy dependence on those markets has once already—in 1951/52—caught the industry napping when the Australian and other governments imposed severe restrictions on imports of cars. There is an obvious need to spread total exports more widely over the world, to avoid being dependent on the policy of one Government or on the fluctuations of certain important crops, such as wool.

The most cheering sign arising from last year's figures is the considerable progress made by British cars in European countries, particularly Scandinavia. If progress in those markets can be maintained, and is assisted by the British industry's ability to sell its cars at lower prices and to give better value to the European motorist than its principal competitors, half a million cars is a modest target to aim at for 1960.

SEVERE CONTINENTAL COMPETITION

As widely expected by motor vehicle manufacturers, competition from the Continent is becoming increasingly severe, and the result of the battle for the small-car market that is now being waged is by no means a foregone conclusion. The German Volkswagen, the French Renault and the Italian Fiat are the leading European contenders and all are increasing their output. As stated earlier, the Volkswagen is a very competitive motor car, and the latest Fiat, the " 600 " fitted with a watercooled engine of 633 c.c. capacity, is likely to offer severe competition to British cars in the medium-price brackets such as the Austin A40. Success during 1955 in non-Commonwealth markets, where cars in 1954 accounted for 59 per cent. of the total value of British trade, would almost certainly vindicate the industry's confidence in the future, but the struggle will be a hard one.

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DIRECT-CURRENT TESTING OF STATOR WINDINGS

Results not Indicative of Serviceability

A paper entitled " An Examination of High-Voltage Direct-Current Testing Applied to Large Stator Windings " was read before the Supply Section of the Institution of Electrical Engineers on Wednesday, March 16, by Mr. R. T. Rushall and Mr. J. S. Simons. The authors pointed out that recently a high-voltage direct-current test had been introduced in America as a means of establishing insulation quality non-destructively, since it was claimed that the direct-current/voltage relationship often enabled a prediction of breakdown voltage to be made. The test required the measurement of the steady-state leakage current between the winding and core at successive increments of voltage up to a maximum of about twice the alternating test voltage (root-mean-square) of the machine, that is, up to 46-kV direct current for a new 11-kV machine. If the breakdown voltage of the weakest point of the winding lay within this range it was held that this would be revealed by a sudden trend towards high current and low resistance.

Laboratory tests, which were described in detail in the paper, applied to a range of specimens of sheet insulation including a number with artificially-formed faults, showed, however, that although attractive, the only breakdown which could be predicted by this method was that across air paths external to the specimen. Tests carried out on a complete high-voltage stator winding and on single stator coils gave similar results. Moreover, no assessment of slot-insulation quality was possible; the only increase in current, suggestive of approaching failure, resulted from end-winding leakage and discharge effects. Surface contamination of the end winding and even quite extraneous dischanges, when present, had a marked influence on the current measurements.

The authors therefore concluded that non-destructive tests with high-voltage direct current failed to distinguish between good and deliberately faulty specimens of insulation. Both gave smoothly-rising current/voltage curves free from any feature by which a breakdown value could be reliably assessed. Only when surface discharge was involved in the breakdown process—as in the surface-leakage form of test—was a prediction of failure possible, and in such cases the failure so predicted was essentially that of the air path.

Tests of this nature, whether applied to a complete high-voltage stator winding or to single coils, could, in fact, lead to no real judgment of the electric strength of the slot insulation. Whenever a sudden increase of current, suggestive of approaching failure, was obtained in such tests it was derived principally from discharge and leakage effects in the end-winding, which differed so materially from those under alternating-current conditions as to render the results irrevelant to an alternating-current machine in service.

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DUAL-TRACE OSCILLOSCOPE

The equipment division of Mullard, Limited, Century House, Shaftesbury-avenue, London, W.C.2, have introduced high-grade general-purpose oscilloscope, type L 101, which incorporates a dual-trace facility, and has wide-band amplifiers, sweep expansion, and stabilised voltage supplies. A tubular-steel movable floor stand and an oscilloscope camera are available as accessories. The instrument should be of value for the comparison and measurement of complex waveforms.

The dual-trace facility is provided on a conventional 5¼-in. tube by means of two identical Y-amplifiers and an electronic switch. Each amplifier is switched through to the cathode-ray tube on alternate sweeps, the electronic switch being operated during flyback. There is no interaction between the channels, each of which has a frequency response from 10 cycles per second to 4 megacycles. The rise time of the amplifiers is 0·1 microsecond. Identical attenuators embodying close-tolerance high-stability components are provided for each channel. These permit the sensitivity to be adjusted from 0·02 volts peak to peak per cm. to 100 volts peak to peak per cm., in 12 steps. The frequency response of the amplifier channels remains constant for all attenuator settings. Voltages can be measured within 5 per cent. The dual-trace facility can be switched out when not required.

The Miller time base can be free-running, synchronised or triggered. Sweep velocity is variable between 10 cm. per microsecond and 0·1 cm. per millisecond. The sweep length may be expanded in three switched steps to 10 cm., 20 cm., and 50 cm. Velocity adjustments have negligible effect on sweep length. Time can be measured with an accuracy of ± 10 per cent. The time-base output stage can also be used as an X-amplifier with a sensitivity of 0·7 volts per cm. and a bandwidth of 2 cycles per second to 300 kilocycles. There are no electrolytic capacitors used, and the oscilloscope is suitable for semi-tropical use.

REMOTE CONTROL

MANUAL AND AUTOMATIC SYSTEMS

The general principles of instrumentation and distance controls, illustrated by particular examples as applied to marine mechanical machinery, were discussed in a lecture entitled "The Application of Modern Instrumentation and Distance Control of Machinery," given recently by Mr. R. H. Paddon Row, engineer in charge of the Land Boiler Design Department of Foster Wheeler Limited, before the Institute of Marine Engineers in London. In the first part of the paper, the lecturer described the various types of instrument employed—including the use of television—for the measurement of temperature, pressure, level and quantity, power, speed and movement, flow, and gas and water anaylsis. We give below an extract from the middle section of his paper, which was concerned with distance controls. The last part of the paper dealt with arrangement and application, including detailed descriptions of several marine installations; a brief extract of some of the principles of layout given by the author is included in our summary.

MANUAL CONTROLS

Distance manual controls may be mechanical, electrical, fluid, or a combination of these.

Mechanical controls are simple and quite effective so long as the distance involved is not great. Modern developments use sheathed wire or flexible cable arranged to transmit power both in compression and tension. These operate very satisfactorily over medium distances so long as reasonable bends are maintained for negotiating corners. It is difficult to design a system for fine adjustment due to the lost motion which is always present and increases with use, but for on/off operations such as shutting and opening dampers and valves, the mechanical type of distance control is satisfactory for small force requirements.

If the system has become jammed or disconnected the operator is immediately aware of the fact by the "feel" unless the frictional force of the operating mechanism is a very large percentage of the total force required for movement. In a system employing rods it is preferable to design for the rods to be in tension when transmitting the greatest force as this enables lighter sections to be used and eliminates lost motion due to flexing.

With electrical distance controls it is necessary to fit some type of indicating system to enable the operator to know that his initiating movement is being followed. The distance control of electrical machinery can be carried out directly by a remotely positioned rheostat for speed control of motors or indirectly through relays. The latter system is used extensively for the control of high voltage systems. For on/off operation, magnetic valves are used extensively in the smaller sizes and lower pressures (up to 8-in. diameter valves and approximately 100 lb. per square inch gauge pressure). For high power output requirements it is necessary to use electric motors in conjunction with gearing.

The fluid method covers both pneumatic and hydraulic operation, the former requiring a constant air supply of approximately 100 lb. per square inch gauge while the latter usually employs a pump supplying oil under pressure. The pneumatic system uses low pressure air at 17 lb. per square inch gauge (some types use a slightly higher pressure) in the control circuit regulating the higher pressure air entry to the "slave" which consists of a double-acting piston and cylinder arrangement fitted with a control valve. The arrangement employs a feed back system which gives a definite piston position for a given control input pressure.

The hydraulic system when used for manual control does not incorporate a positioning device. The operator switches oil to one side of the "slave" piston and then returns the switch to the neutral position when either the indicator shows the required movement or the process change has been affected.

Connection between "slave" and regulating unit is made through a short mechanical linkage and means are provided in both systems for equalising pressure on both sides of the piston to enable local hand operation to be carried out.

Systems in which the "slave" units are pneumatic or hydraulic while distance control is exercised by electrical methods are not uncommon. It is convenient occasionally to employ pneumatic control actuating a hydraulically operated "slave" and at least one control system uses electric motors mounted at the remote control point and driving the regulating unit through a system of wires.

AUTOMATIC CONTROLS

There are two main types of automatic controls, one self-actuating and the other requiring a source of fluid or electric power for its operation. The self-actuating type is a closed system depending on expansion of metals, vapour or liquid, or utilising the power in the controlled system by means of diaphragms or pistons. The metal-expansion type is used for local operation in such apparatus as steam traps where the movement required is small. Vapour- and liquid-filled systems are used generally only for temperature control and are restricted to the moderate upper limit of about 450 deg. F. It is sometimes possible to utilise the power in the controlled system; a common instance of this is the pressure-reducing valve. These instruments are not suitable, for very accurate control.

In the second system, whether it be fluid or electrically operated, there are a number of common main items which are normally included in the complete circuit as follows:—

(1) The detecting and measuring elements, which may consist of a thermometer and bourdon tube or a differential-pressure measuring device.

(2) The equipment which connects the measuring unit to the controller. This may consist of connecting piping or direct mechanical linkage, or of an instrument transmitting a fluid or electric impulse.

(3) The automatic controller. This may incorporate both indicating and recording equipment. The controls are normally based on a primary system which sends out an impulse which is proportional to the deviation from the desired value, but often incorporate extra functions also.

(4) Relays by which the automatic function may be cut out to enable the operator to control the system manually from a remote point.

Some controllers carry out a proportional function only, and if it is required to impose integral and derivative action on the output, then these are carried out by means of relays.

(5) The final regulating unit (or "slave"). This element can vary very widely, depending on the duty it has to perform, and may be a simple diaphragm-operated linkage or a self-contained electro-hydraulic system.

(6) The final connecting linkage.

Where possible, a "closed loop" system should be employed, i.e., a system in which the detecting element controls through an automatic controller the regulating unit which directly changes the condition of the plant. When it is not possible to instal such a system an "open loop" or "cascade" system is employed. The "open loop" type of system is usually necessary in controlling such phenomena as temperature in which deviations from the desired value may be brought about by more than one external source of change which is not directly controlled by the system. It is also necessary when, for instance, the final product control is obtained through the regulation of an intermediate fluid which is in turn itself controlled. For example, if temperature control is carried out by varying the amount of water flowing through a heat exchanger where the water supply pressure may be very variable, then it would be necessary to instal a water flow controller having its desired value set by a temperature controller.

Where it is possible in a system to choose between the application of pressure and temperature control, the former would in most cases be preferred. A pressure-control system may be designed with a detecting element having a very low inertia, while in measuring temperature, especially under high-pressure conditions, the heat inertia involved may be quite large. For temperature control the quickest acting arrangement is a combination of a resistance thermometer or thermocouple with an electronic controller.

Integral action, which continues until the process has been restored to the desired value, is required if it is necessary to maintain the desired value over wide fluctuations in the process load. It is necessary to incorporate a derivative function where it is required to overcome inertia or initial lag either in the process itself or some part of the controlling system.

Derivative action, which is only initiated by a changing error and is not sensitive to the magnitude of error, produces an acceleration effect which dies away with time. In pneumatic systems this is sometimes carried out by restricting the rate at which the proportional device reacts to unbalanced conditions, but some types employ separate relays to give the accelerating, or temporary over-correcting, effect.

When the control room is situated a considerable distance from the point of measurement and the regulating device, it becomes necessary to fit a transmitter to the detecting element. The controller can then be fitted close to the final controlling element while the indicating, recording and remote manual control equipment may be positioned in the control room. This type of arrangement reduces the control lag which may be present due to long transmission lines.

ARRANGEMENT

It is essential that the result of any modification carried out by the operator should be made immediately apparent to him, even if this is shown without any great degree of accuracy.

With regard to fatigue, it has been found that an operator will carry out supervision of current operation more conscientiously if excessive movement is not entailed. The necessity for more or less continuous movement in order to observe conditions (as in most naval ships built prior to 1946) leads to a falling-off in enthusiasm, especially during night hours.

Miniature instruments have been developed both for recording and indicating. It is becoming accepted practice to eliminate all high pressure lines from the control room panel and transmit the important variables by either pneumatic or electrical means. The panel instruments are then designed to indicate and record the desired range of values when receiving a pneumatic or electric impulse of, say, from 3 to 15 lb. per square inch gauge or 0 to 30 milliamps respectively.

To enable the operator to observe at a glance any deviation from correct operation the main indicating gauges are sometimes arranged so that all the pointers are in a horizontal line when the plant is operating correctly; any deviation from the normal operating position is then readily observable. "In-line scanning" employs an indicator receiving an impulse from the measuring unit transmitter and incorporating a manually-operated counter-loading arrangement so designed that the indicating pointer is horizontal when the transmitted impulse is exactly equal to that imposed on it by the manual adjustment. It has the advantage of flexibility and may be employed where process requirements are changed from time to time. Where the indicated value is under proportional control only, a restricted movement is employed corresponding with the width of the control band; that is to say, in indicating a pressure from a controlled system having a proportional band width of 20 lb. per square inch the "in line scanner" would have a restricted movement so that a deviation of $\pm$ 10 lb. per square inch would not move it appreciably out of line.

WIND-GENERATED ELECTRICITY

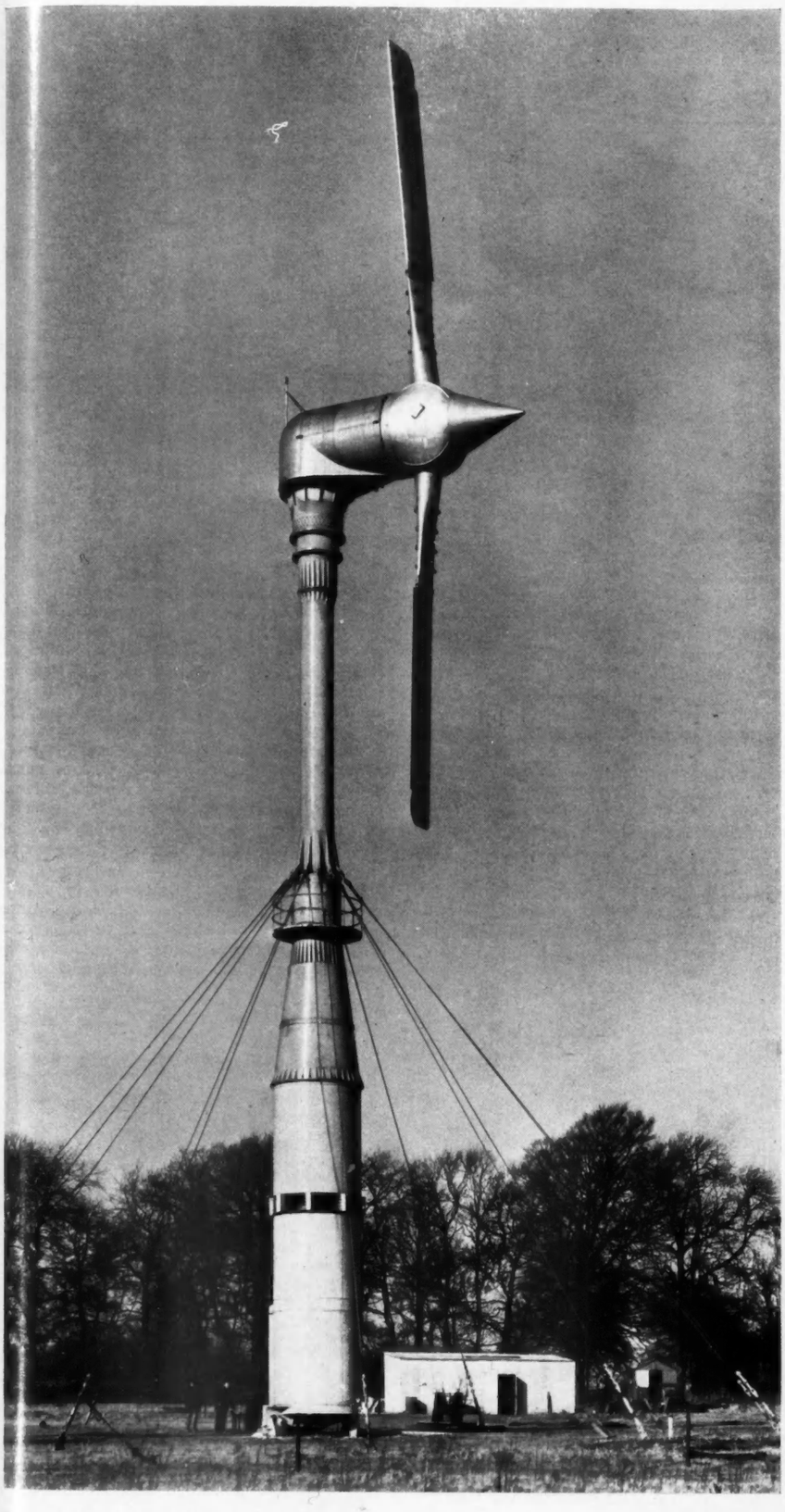


Fig. 1 The blades of the wind-driven generator are each 40 ft. long, and the axis of rotation is 100 ft. above the ground.

PROTOTYPE 100-KW PLANT

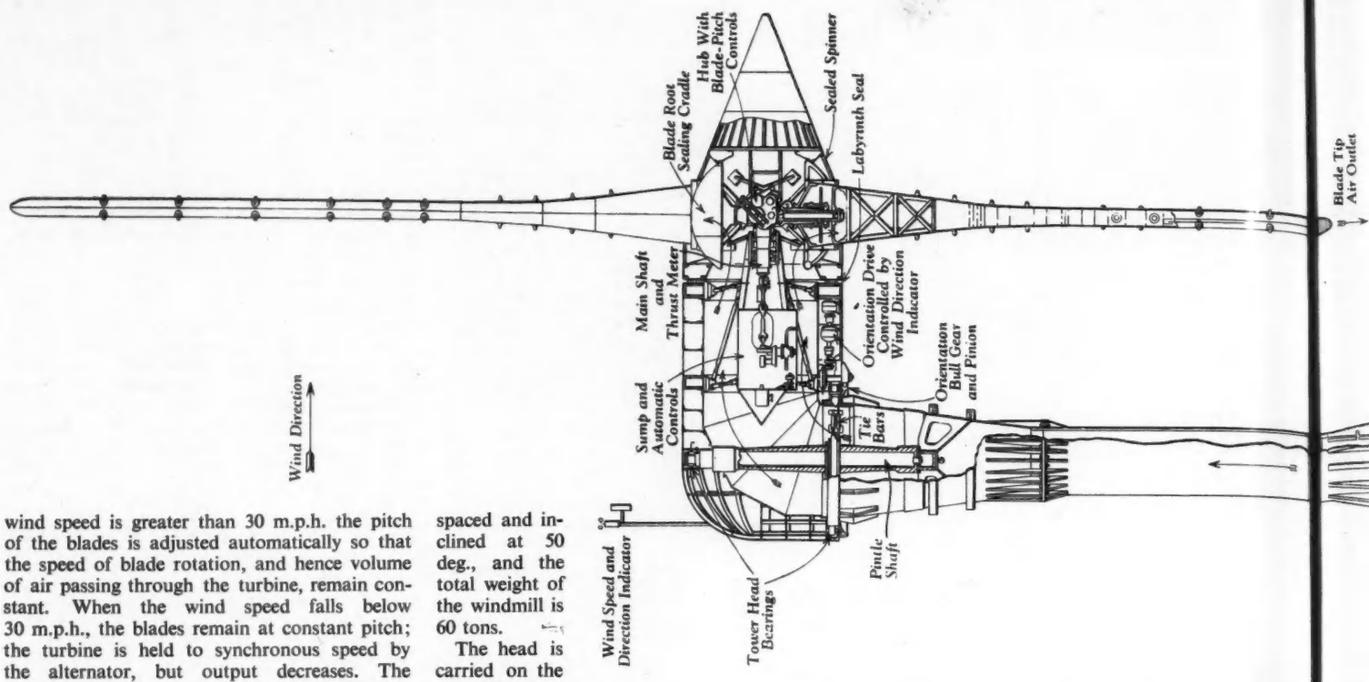
"The wind goeth toward the south, and turneth unto the north; it whirleth about continually, and the wind returneth again according to his circuits." Of all the resources with which this planet is blessed the most capricious is wind power; to-day the wind is no more dependable than it was in the time when Ecclesiastes was written. But for many years engineers and others have devised schemes for harnessing the power of the wind to the service of mankind. Windmills have provided power for millers, but in many cases they have had to be built in inconvenient or isolated places and the power developed is small. If the power of the wind is to serve the community generally, it must first be transformed into a readily transmissible power. Experiments have been conducted in recent weeks with a new type of wind-driven alternator on a site at Prae Wood, near St. Albans.

The plant has been described in general terms in ENGINEERING of February 13, 1953 (vol. 175, page 213), and the possibilities of wind power were discussed in the issue of July 10, 1953 (vol. 176, page 33). A general view is given in Fig. 1, and a drawing of the machine with its 100-kW alternator in Fig. 2. It has been built for the British Electricity Authority as part of their investigations into the use of wind power for generating electricity. The main contractors are Enfield Cables, Limited, Victoria House, London, W.C.1. Sub-contractors are de Havilland Propellers, Limited, Hatfield, Herts., who designed the machine generally and made the head, blades, and turbine; Redheugh Iron and Steel Company (1936), Limited, Teams, Gateshead, who were responsible for the steelwork and erection (stages during the erection are shown in Figs. 5 and 6); and the English Electric Company, Limited, Kingsway, London, W.C.2, who designed and made the electrical equipment.

"DEPRESSION" PRINCIPLE FOR FLEXIBILITY

The generator works on the "depression" principle, which had been tested on a small scale by the late M. Andreau in France. The propeller blades are hollow; and as the force of the wind makes them rotate, so air is discharged through the blade tip outlets due to centrifugal action. As a result, air is drawn through an air turbine near the base of the tower, up through the tower and through the propeller hub to the tips. The construction of the blades is shown in Figs. 4 and 5. The turbine drives the alternator, which is housed at the base of the tower together with the control gear, as shown in Fig. 2.

The main difficulty when using wind power is that the power available varies continuously. If the blades of the windmill and the alternator were connected by mechanical linkage, it would be necessary to incorporate a clutch in the linkage so that sudden changes of torque were not transmitted to the alternator, thus adding to the cost, weight and complexity of the plant. The method adopted means that the connection between blades and turbine is a column of air, which gives the plant the flexibility it needs; clutch, gearing and shafting are not required. The windmill is designed so that when the wind speed is 30 m.p.h. the propeller runs at 100 r.p.m.; at that speed 58,500 cub. ft. of air pass through the turbine per minute. When the



wind speed is greater than 30 m.p.h. the pitch of the blades is adjusted automatically so that the speed of blade rotation, and hence volume of air passing through the turbine, remain constant. When the wind speed falls below 30 m.p.h., the blades remain at constant pitch; the turbine is held to synchronous speed by the alternator, but output decreases. The power in the wind is proportional to the cube of the wind speed, and as wind speed falls below 30 m.p.h. output decreases rapidly. Between 30 and 65 m.p.h. output is held at the rated figure of 100 kW, and when wind speed rises to more than 65 m.p.h. the blades are feathered and rotation ceases.

MECHANICAL DESIGN

The tower foundations are of reinforced concrete with 12 anchors arranged on a pitch circle 96 ft. in diameter. These foundations carry a 100-ft. tower, which is of stressed steel plate, and decreases in diameter from 9 ft. at the base to 3 ft. 6 in. for the part above the guy-ropes. The diameter of the swept circle, blade-tip to blade-tip, is 80 ft., and the weight of each blade is 1,600 lb. The tower is supported by 12 galvanised steel cables, which are equally spaced and inclined at 50 deg., and the total weight of the windmill is 60 tons.

The head is carried on the top of the tower on the tower head bearings shown in Fig. 2, and rotates about a pintle shaft. The wind direction indicator, the mounting for which is shown in Fig. 3, is designed to control orientation of the head on an operational site. The orientation drive, which is on the floor of the head, is controlled by the direction indicator and drives the head round so that it always points away from the wind. The main bearing housing, indicated in Fig. 2 as "sump and automatic controls," is totally enclosed and contains oil. A pump in the sump lubricates the main bearing. Driven through gearing off the main shaft is a fly-weight governor which controls valves admitting oil to the hydraulically operated pitch-change motors; with change of wind and hence shaft speed the pitch-change motors operate to restore the shaft speed to 100 r.p.m. The pitch-change motors can operate if necessary to change the pitch 20 deg. in one second; over the working range the blade pitch changes only 15 deg., so variations of shaft speed from 100 r.p.m. can only last for fractions of a second. Overspeed emergency controls feather the blades and stop rotation when the wind exceeds the maximum of 65 m.p.h. These controls consist of electrically-operated valves which open a reservoir of oil, kept under a pressure of 350 lb. per square inch, to the pitch-change motors; the motors then bring the blades into the feathered position, in which they lie in a plane with the axis of the main shaft.

The blades are carried on coning bearings so that they take up equilibrium positions when acted upon by centrifugal and thrust forces. If they were attached rigidly to the hub the blade roots would need to be very strong and conse-

Fig. 3 The mast at the back of the head is for the wind speed and direction indicator; indications from this instrument control the orientation of the head.

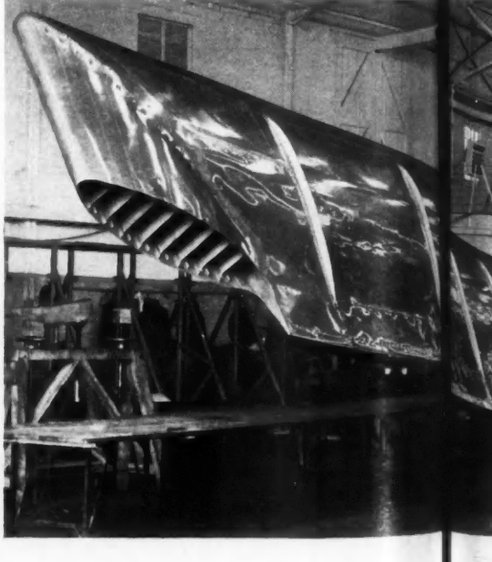


Fig. 4 The blades during

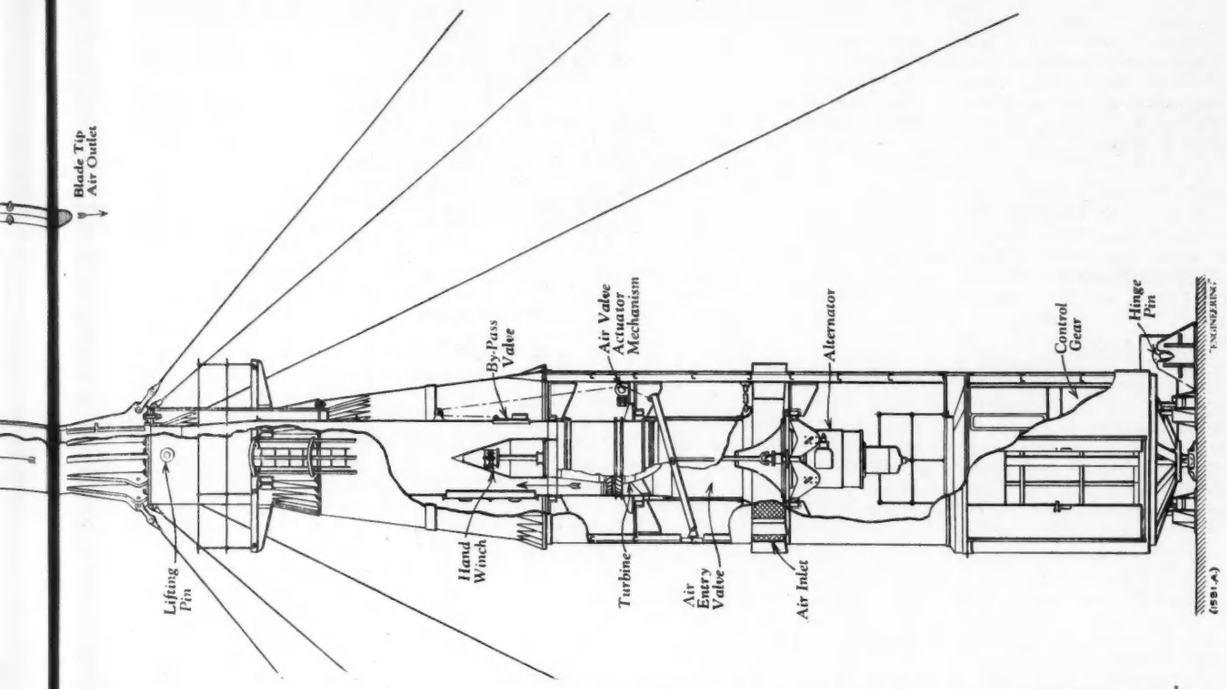


Fig. 2 When the blades rotate air is discharged through the blade-tip outlets by centrifugal force; this air is drawn up through the air turbine and tower, and the turbine drives the alternator.

quently the size and weight of the head would be increased. Movement of the blades about the coning bearings is controlled by hydraulic shock absorbers with variable rates of damping. The normal position of the blades is leaning backwards—that is, away from the tower—at an angle of 5 deg. About this position damping is slight, but increases towards the extreme positions of the blades, which are 18 deg. backwards and 8 deg. forwards.

The whole of the interior of the head is under slight vacuum when the windmill is in operation, and the labyrinth seal shown in the drawing ensures that the junction between the fixed and the rotating part of the head is airtight. The thrust meter shown in the drawing is an alternative method for controlling the blade pitch. Increased wind-speed causes a rise in thrust; a signal is sent from the thrust meter which coarsens the blade pitch, and reduces the speed of the propeller. Control by the thrust meter is expected to give improved specific output.

ALTERNATOR CONTROLS

The turbine is of the axial-flow single-stage type, and its 48-in. diameter rotor is carried on a vertical shaft. There are 47 blades on the rotor and 50 on the stator, and the angle of injection is 28 deg. Its design speed is 1,000 r.p.m., and its estimated efficiency 85 per cent. The turbine is coupled through a free-wheel mechanism to a 100-kW synchronous induction alternator made by the English Electric Company, Limited. It is a three-phase 415-volt alternator, with an exciter carried on the shaft.

The control system has been designed so that the generator can work completely automatically on an operational site. As yet, however, it has not been possible to test the automatic controls fully, because the wind at the present site is too variable. To cope with rapidly varying wind direction, it is more satisfactory to control the plant manually while it is still experimental.

When the generator is working with no attendants, starting up and shutting down will be controlled by the wind speed registered by the anemometer. When a certain wind speed, probably about 15 m.p.h., is registered, a contact is brought in which energises a timing relay. After a time determined by the relay an auxiliary contactor relay is energised and the auxiliary contactor closes. Closing the auxiliary contactor brings in the main contactor, and energises a number of other relays. One of these controls short-circuiting switches for the rotor resistances; the alternator starts as an induction motor, runs up to speed, and the short-circuiting of the rotor resistances, after a

e blades during balancing.

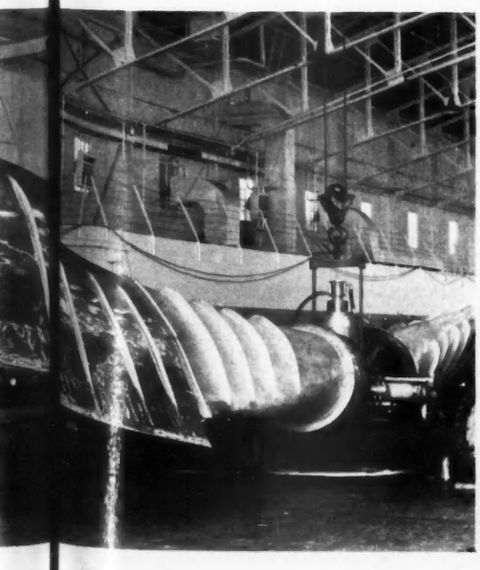


Fig. 5 The construction of the blades can be seen here, as well as the blade tip outlet. Each blade weighs 1,600 lb.

pre-set time delay, brings it to just below synchronous speed. Closing the auxiliary contactor energises another time-delay relay, which brings in the exciter after a certain delay; direct current is then supplied to the alternator rotor, which is pulled in to synchronous speed. The auxiliary contactor also makes the circuit controlling the air-valve actuator mechanism (shown in Fig. 2 near the turbine). This mechanism raises the air entry valve, which is cylindrical in form, and admits air to the turbine. When the alternator is running at synchronous speed the air valve is opened, air is admitted from the air inlet through the turbine blades and up the tower, and the turbine starts to rotate. Until it reaches 1,000 r.p.m. the turbine rotates independently of the alternator. At 1,000 r.p.m. the free-wheel mechanism causes the turbine to latch on to the alternator shaft, and the synchronous motor becomes an alternator.

The plant is supplied from the Eastern Electricity Board's distribution network through an overhead line and a 11,000/415-volt 200-kVA transformer. When the plant generates, current will be fed back through the transformer into the network, and imports and exports of power will be appropriately registered. Protection of the generator is by thermal overload relays, backed up with fuses.

SELECTION OF SITES

Before a wind machine is constructed for use, say in Great Britain, a detailed investigation must be made into the amount of wind power likely to be available in the country. Sites for wind machines must be chosen with care, and some of the relevant factors are discussed below. The first requirement is that the site is windy; that is clear enough, but in more precise terms it means that the annual wind velocity duration curve must be of the right shape and area. The annual average wind speed can now be taken as a pointer to the suitability of a site; it has been found that for similarly shaped hills in western coastal districts of the British Isles the same annual average wind speed indicates that the annual wind velocity duration curve will be the same. Taking into account the cost of electricity generated by conventional methods, and the probable cost of constructing wind-driven generators (estimated at between £50 and £100 per kilowatt), a site in this country should have an annual average wind speed of 20-25 m.p.h. if its use is to be economic.

The Electrical Research Association have made a most comprehensive survey, some of the results of which are detailed in their reports W/T 16, C/T 101, and C/T 108. They have found that a fairly steep smoothly shaped hill gives good results when it is well exposed, is not screened by higher ground within 3 to 4 miles, and is near the coast. In the survey, hills were chosen as sites for the erection of recording instruments which had slopes not exceeding 1 in 3 and were not more than 2 to 3 miles inland. The change of slope at the top should not be so sudden that the wind tends to break away and gives rise to turbulent effects. Isolated hills are preferred to long ridges. The wind tends to accelerate over the top of the hill, and in the case of a ridge this accelerating effect only occurs when the wind is in one particular direction; in the case of an isolated hill the effect will be felt to some extent wherever the wind is. Sites should be free of trees and precipitous outcrops of rocks, both of which cause turbulent flow.

Other factors which help to determine whether the site can be used economically are ease of access, nature of the ground at the summit, and distance from the electrical network. A reasonable road or track to the summit will lower the costs of construction, and the nature of the ground at the summit will affect the cost of the foundations. The distance from the remainder of the electrical network will largely determine whether a site is worth developing, since the cost of connection and transmission losses should form as low a percentage as possible of the total cost. In selection of a site trouble from icing and salt spray must also be considered; icing has only caused trouble at one of the E.R.A.'s sites, and that was over 2,000 ft. above sea level.

STORING ELECTRICAL ENERGY

There have been and are other types of wind-driven generators which have delivered electrical energy to local networks, notably in Denmark. But the "depression" principle has not hitherto been used to drive such a large generator, and its advantages, already mentioned, may make its general use more convenient. When—and not until—sufficient experience has been gained with this 100-kW prototype plant, it will be possible to make similar wind-driven generator sets for use in suitable locations in both the British Isles and overseas.

In places such as the western and north-western coasts of Australia, and parts of the western seaboard of the United States of America, this type of wind machine could be used for pumping water. It would not be necessary to convert the output of the turbine to electrical power for this purpose, but conversion involves no great loss of efficiency, and affords the convenience of electricity for lighting and other power applications. In such locations the water can be pumped to storage tanks or reservoirs whenever the wind power is available to drive the generator, and in effect the energy output is stored. The problem of energy storage is the major problem when using wind power; if electricity is to be of use to a community it must be readily available whenever it is needed. If the supply depends upon the force of the wind then it will be intermittent. Various ways of overcoming this problem have been put forward, of which one is applicable to small quantities of energy and three are of general, although sometimes difficult, application. The first is the use of electric batteries and a direct-current generator; in general, this can only be used for small quantities of energy, and even then the capital cost of the batteries is often prohibitive. The second is the storage of energy by pumping water to a level where its energy can be used when required. This is allied to the schemes mentioned for pumping water in Western Australia, and in some cases it might be possible to use the energy of the stored water for conversion to electrical energy and subsequently to use the water for irrigation. In conjunction with a hydro-electric scheme, wind-generated electricity can pump water back to the reservoir. This can only be useful in places where there is sometimes a shortage of water in the reservoir, and water can be taken from the tailrace and pumped back by wind-power to supplement the available supply. This method of storage is already in use at a number of places.

The third method of storage is thermal storage, in which the electricity generated is converted to heat and stored in an insulated container. A system of thermal storage is used at present for off-peak loads by electricity boards; consumers are encouraged to use electricity at night to heat up storage radiators or storage elements in steam-raising cabinets. When the electricity is switched off, the radiator gives out heat for a period depending upon its thermal capacity. In dairies thermal storage is used for sterilisation. The storage block is heated during off-peak hours; at the desired time a measured amount of water falls at a pre-arranged rate on to the heated block and is converted to steam, thus sterilising the utensils within the sterilisation chamber.

The fourth method of energy storage is to use the electricity generated by the wind machine for the hydrolysis of water, and to store the hydrogen evolved. The hydrogen can then be used for heating, cooking and could also be used for power applications.

Enfield Cables' plant at Prae Wood is still experimental, and there may be difficulties to be overcome before it is fully operational. But in view of the decreasing oil and coal resources of the world, any method of generating useful power from Nature's gift of the wind must be of great value. In finding suitable methods of storing energy new techniques may have to be evolved and tried, some of which may be found to be unsatisfactory and which may have to be discarded. But progress has never been made except by facing and overcoming difficulties, and the effective harnessing of wind power is one of to-day's major challenges to the engineer. Already there must be many places in the world where, because of local conditions, non-availability of fuels, etc., wind power could be applied with advantage.

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Fig. 6 The site where the wind-driven generator has been erected is an experimental site only. After trials it is expected that the plant will be moved to an operational site.

PREVENTING THREAD SEIZURE

Crane Packing Limited, Slough, Buckinghamshire, are now marketing a compound known as Thred-Garde for application to screw threads to prevent seizure under load. The basic constituent is molybdenum disulphide, and it is stated that the compound will not drip or harden during service. The compound can also be used as a lubricant in drawing, broaching or tapping operations.

DETECTING LEAKS IN BURIED PIPELINES

PREVENTING CORROSION AND ENSURING SOUND JOINTS

By A. C. Vivian, A.C.G.I., M.I.C.E.*

A technique has recently been developed in the field for finding leaks in buried sections of pipelines which are tested with compressed air prior to the commissioning of the lines for service, and the success of the new technique justifies publication of this report as a matter of interest to those concerned with pipeline installations.

The photograph shows the apparatus used for exploring for leaks along a pipe under air-pressure test buried in the verge of a road. The apparatus itself has long been used for finding leaks at joints of refrigerating plant, but its use in the field, as described here, is new. The apparatus which is all portable, comprises a detector unit, a control unit and an electrical supply. In the detector unit there is a pair of concentric platinum sleeves enclosed in a glass envelope and heated to 800 deg. C. The inner sleeve is an anode, the outer the cathode; and through these is drawn a sample of the air surrounding the pipe joint by means of a small electrically-driven fan in the detector (pistol-shaped) part of the apparatus, which in the illustration is being held, for demonstration purposes, over a bar hole made in the ground. This particular apparatus, being a factory model, is designed to run off a 250-volt alternating-current lighting circuit. For field use it has been necessary to equip a Land Rover with a petrol engine and an electric generator, and about 260 yards of cable to bring electric current to the control unit.

The control unit includes an amplifier, voltage-stabilising transformer, indicating instruments and a loudspeaker "ticker." The apparatus is set to give steady ticks, say two per second, and is so sensitive that one part per million of halogen gas in the atmosphere drawn over the heated platinum gives an immediate audible increase of sound. A new model of the leak apparatus is expected soon which will be operated from a 6-volt car battery and will thus eliminate the need for a 250-volt motor-generator set. In either case the apparatus is portable and adaptable; buried pipelines in roads, along the verges or across fields can therefore be tested methodically.

The method has been applied particularly to testing sections of buried mains being installed for gas undertakings, where it is usual for convenient lengths to be stopped off after laying and the internal pressure raised to 15 or 50 lb. per square inch using a standard mobile air compressor. The main is taken up in the course of a few hours to the required pressure, using a sensitive gauge, and is then sealed off. After 24 hours the pressure is again tested, and if the pressure drop is more than a small amount, say ½ lb. per square inch, depending on the size of the main and specified test pressure, the section of main is not accepted and the contractor must find the leaks. This has often been done in the past by using ethyl mercaptan (or "stink gas") but the new technique, using the halogen leak detector, promises quicker and more positive results. The procedure now is to introduce into convenient lengths of main under test a small quantity of halogen gas with the compressed air, to bleed off at the far end of the main until a positive reaction with the halogen leak detector is obtained, so proving that the whole main under air test has a proportion of halogen gas in it, and then to go along the main methodically joint by joint and, if there is any reason to suppose a cracked barrel anywhere, between the joints as well. The technique is still being developed, but in general a number of bar holes of about 1-in. diameter are worked down around each joint and an aspirator withdraws a sample of the atmosphere surrounding the joint; this is then tested in a safe place by the halogen leak detector. The illustration shows the apparatus, for the sake of completeness, all together and adjacent to the buried pipe under test, but in practice proper precautions are taken to avoid the possibility of explosion (since the apparatus is not flameproof) should there be some other service pipes, e.g., gas or oil nearby, which may have leaked and created an explosive atmosphere in the vicinity of the pipe under test.

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CATHODIC PROTECTION

The company developing this leak detection technique has, as its main interest, the development of cathodic protection and of welding supervision, and to both of these subjects, in so far as they apply to buried pipelines, leak detection is an interesting adjunct. Cathodic protection is a subject of wide scope and one in which managements of gas and water undertakings and other companies responsible for buried steel structures now take a great interest. The practice of cathodic protection originated in the United Kingdom over 100 years ago and it is not suggested that it is not already widely practised in this country, but it has been mostly among the big oil companies, both British and American, that the main development work has been done on buried pipelines, and it is with the Naval Departments of the British, Canadian and U.S. navies that cathodic protection has advanced considerably in the safeguarding of ships, both inside and outside.

The principle is as follows. If the buried pipeline or any steel structure in contact with an electrolyte can be maintained at a certain negative potential relative to the surrounding soil or medium, then the pipeline will remain in good condition and a "sacrificial" anode will be dissipated over a period of years at a very considerable saving in overall expense. The reason why a specialist firm should engage specifically in cathodic protection work is so that survey work and expert design work for an economical installation shall be properly executed and tested after installation to ensure the most efficient scheme.

Why, it may be asked, in the case of a buried pipeline, should both an impervious type of coating and also cathodic protection be applied? Usual protective coatings for buried pipelines are nowadays either coal-tar-based bitumen or petroleum-based asphalt reinforced with asbestos or glass fibre. The thickness of the protective coating may be about $\frac{1}{16}$ in. and there may be in addition, for extra precaution against a damaged coating due to subsidence or soil movements, an outer wrap of bitumenised paper or felt.

Regarding the use of both protective coating and cathodic protection, relative costs vary according to a number of conditions, but it can be shown that the cost of cathodic protection for coated pipe, together with the extra cost of the coating, does not necessarily exceed the cost of cathodic protection of the bare pipe and may be considerably less. The reason is that the current density required over the whole of the surface of a bare pipe (to ensure the correct minimum electric potential being maintained) is much more than the current density required to cover the comparatively few imperfections on the coated pipe. Thus the relative costs equalise, or the capital cost of bare-pipe protection may be more if local conditions preclude the ground beds being spaced far apart. The annual cost of current if any kind of cathodic protection is used is, of course, much less with the coated pipe.

The coating, it might be thought, is self-sufficient. So far as the manufacturer is concerned, the pipes leave his works in perfect condition. The contractor who puts the pipes in the ground is equally sure that in the process of putting them into the ground no damage occurs to the pipe surface. And the transport companies carrying pipes between the manufacturer's works and the site accept no likelihood of damage in transit. The plain facts of the case are that however well a pipe is coated and however well it is conveyed to site and put into the ground, it is unlikely that there will not be some breaks in the coating by the time the line is installed and tested, particularly if some changes of temperature in the pipe occur in the ground, or there are soil movements or subsidence. These breaks or "holidays" then form points of accelerated corrosion, and it is to guard against such local

An effective method of testing for leaks in buried pipelines. Halogen gas is introduced into the pipeline with the air, and the pressure is then raised to the test value. The apparatus will detect the slightest trace of halogen in the ground and thus reveal a leak. This method, used in conjunction with cathodic protection and gamma-ray inspection of welded joints, ensures sound pipelines for many years.

damage that cathodic protection is primarily used for buried coated steel lines.

Some striking examples of the cessation of leaks in pipelines have been published, e.g., the leak curve obtained by plotting the cumulative leaks on a basis of years has shown a rapidly rising curve in each succeeding year and then, abruptly—on the application of cathodic protection—a horizontal line. Records go back 20 years or more and the evidence is that pipelines on which the cathodic protection is maintained (with service at intervals to ensure its continuing effectiveness) will remain free of corrosion leaks indefinitely.

WELDED JOINTS

Another matter which is becoming of increasing importance in this country is the adequate supervision of welded joints in steel mains with pressures increasing. There are a number of non-destructive methods for ensuring weld soundness, and of these one of the methods which is most rapidly advancing is that of the gamma-ray test, which provides a visual record of any defects in the welding. Nowadays it is possible to produce a gamma-ray photograph within an hour or two of taking, so that the welder can be shown, during the course of the day, any defects which may have occurred in his welding. The psychological effect on the welders of occasional gamma-ray inspection is considerable and merits close consideration. The final test after the pipeline has been put into the ground is, of course, leak detection, and the method described in the earlier part of this article, when the line can be tested with compressed air, is very promising.

STRUCTURAL SAFETY OF AIRCRAFT

STATISTICAL AND PROBABILITY CONCEPTS

In addition to considerations of the special fatigue and thermal-stress problems that confront aircraft designers, the philosophical approach to structural safety was discussed in a lecture on "Structural Safety" given recently by Dr. A. G. Pugsley, Professor of Civil Engineering, University of Bristol, before the Preston branch of the Royal Aeronautical Society. A summary of Professor Pugsley's lecture is given below.

The estimation of a safe fatigue life depends, among other things, on the scatter of fatigue test results, and on this there have been singularly few adequate experimental results. Now there is a new and more fundamental attack led by Freudenthal and Gumbel. Some of their results from a series of rotating beam tests on 75 S-T aluminium are plotted in Fig. 1 to show the frequency distribution of the measured lives; its adversely unsymmetrical nature is immediately noticeable. The curve gives a "most probable" or median life of 19,117,000 cycles as compared with the mean of 23,324,000 cycles. The standard deviation is 20,038,000 cycles and so approximates to the mean itself. Fortunately, the same results, plotted as a frequency curve against life in cycles on a log. scale, approximate to a normal or Gaussian distribution, a mathematically convenient fact that has been shown to be fairly general. This permits not only the better planning and interpretation of fatigue tests, but also gives hope for estimating fatigue life with greater reliability. The possibility of a large and unsymmetrical scatter of test results in the region of most interest for the estimation of the safe life of an aeroplane nevertheless emphasises the importance of comprehensive fatigue tests on some typical vital parts of aeroplane structures.

In the recent past, English engineers have used Miner's cumulative damage law as a means of determining the most significant constituent, in amplitude and frequency of occurrence in the measured records of flight loads. Recently in France, and now in America, efforts have been made to deduce from the load records a test-cycle programme more representative of the actual random loading. In aeronautical terms, one scheme is to analyse a flight load-time record by a diagram showing the frequency of the occurrence of a given level of load and thence to represent the actual random record by a regularised "stepped" programme of cycles, each of fixed load amplitude, for given periods of time. Such a procedure no doubt introduces the well-known "over-stressing" and "under-stressing" effects present in the real cycle, but leads, of course, to a more complex testing programme. It might be that a simple combination of both approaches—as, for example, the use of the cumulative law cycle with the insertion, at appropriate intervals, of a few cycles of large amplitude loads alternating in sign—would prove a reasonable compromise.

CORROSION FATIGUE

The fatigue endurance limits of metals can be very severely reduced by the presence of salt water or salt spray during the fatigue period. In such circumstances the endurance limits of steels are often reduced to a third of their value in air, and of aluminium alloys to perhaps one half. What is not so commonly appreciated nowadays is that fatigue tests in fresh water show quite large reductions also. Fig. 2 shows the results of some tests by McAdam on a tempered Duralumin. The curves show the large effect of fresh-water conditions, particularly when large numbers of cycles are concerned. They also show how, under corrosive conditions, the increased slope of the S-N curve makes unreal any suggestion—and this applies also to steels—of a definite endurance limit.

In nearly all cases, the corrosion-fatigue endurance limits are much more a function of chemical composition than of static strength attained by cold working or heat treatment. Thus for 10^7 cycles, the fatigue limit for the Duralumin of Fig. 2, whether tempered or annealed, was much the same, although at 10^4 cycles, the former was markedly the better. This is a further handicap to the use of many modern alloys under fatigue conditions.

These effects of corrosive influences upon fatigue may not always be on the debit side from the designer's standpoint. Gough and Sopwith found from tests *in vacuo* that conventional tests "in air" might themselves involve corrosive influences. More fundamentally, they also showed that the presence of oxygen and of water vapour were key matters. Flight at high altitude may have advantages on these counts.

The effect of exposure to corrosive conditions *prior* to fatigue testing is also of interest. Tests by McAdam and Clyne, conducted on a variety of metals, using water with the addition of some washing soda as a corrosive medium, showed that the corrosion "damage," so far as fatigue is concerned, is largely done in the first few weeks of immersion. The stronger alloys are the ones most affected by pre-corrosion.

So far as the effects of pre-corrosion are concerned, conventional protective measures are largely effective. It appears, however, that commonly available methods of protection against corrosion are, so far as corrosion-fatigue is concerned, only partially effective in salt-spray conditions. Some very recent work, however, has shown a particular paint to give an aluminium alloy (H.10) very substantial protection against corrosion-fatigue.

These results have been mentioned not to suggest that corrosion-fatigue is a major factor affecting safety to-day so much as to bring it to mind when conducting or interpreting fatigue tests on aeroplanes and to make a plea for a revival of its study and an extension of past work to cover modern aeronautical conditions. Of particular structural importance would be corrosion-fatigue results for notched bars and for typical joints.

THERMAL EFFECTS

Short period effects due to rapid changes of surface temperature are likely to prove of considerable importance in aeronautical structures. Such rapid changes may arise, for example, from descent at high speed after prolonged cruising at high altitude; when aeroplane speeds approach Mach numbers of 2 or 3, the temperature changing as the vehicle gains speed and altitude from the ground. In fact, the problem will be to ensure, during the short time of flight, that temperature conditions at various parts of the vehicle, although continuously rising, do not reach certain critical values. The aircraft will, in effect, be judged for its safety in terms of its temperature endurance (in hours or distance) compared with the duration of flight or range required of it. Safety margins can be introduced—or ranges extended—by the introduction of refrigeration or of insulating coverings. Without such amelioration, a skin temperature rise of 100 deg. to 150 deg. C. would occur for an aeroplane flying at Mach 2 for only 10 minutes. This short endurance could, however, be transformed to a few hours by an insulating covering an inch or so thick.

The most damaging effects will be due to temperature gradients within the structure, giving stresses both difficult to estimate and difficult to assess in effect, particularly when superposition of manoeuvring or gust loads is envisaged.

The temperature cycles thus arising in flight will, in the case of manned aeroplanes, tend to occur on every flight, corresponding to a condition of repeated thermal loading. For very high speeds, the peak temperatures in each cycle, and the internal stress distribution associated therewith, may be such that local plasticity and creep may occur, and the thermal cycle thus lead to progressive changes in the structure.

The maximum stress occurring in a wing of given material when the surface air temperature changes by T deg., is given approximately by $E \alpha T$, where E is Young's modulus and α the linear coefficient of thermal expansion. For an all-aluminium alloy wing, this stress, which occurs in the wing webs, is about 10 tons per square inch. for T = 100 deg. C., and for an all-steel wing, about 15 tons per square inch. The response of the wing to repeated exposure of such temperature changes clearly depends on the relation of $E \alpha T$ to the margin between the yield stress and the peak stress due to ordinary flight loads. If the thermal stresses $E \alpha T$ exceed the margin but do not exceed the yield stress itself, the structure will "shake down" to a state of elasticity; on the other hand, if the thermal stress $E \alpha T$ exceeds the yield stress, a condition of alternating plasticity leading to failure after a number of cycles, or a condition of increasing permanent deformation, arises.

With a self-equilibrating system of stresses such as that due to a thermal change, creep and time play a major part in determining what internal stresses actually arise. Freudenthal has shown that for a visco-elastic bar with creep (Maxwell

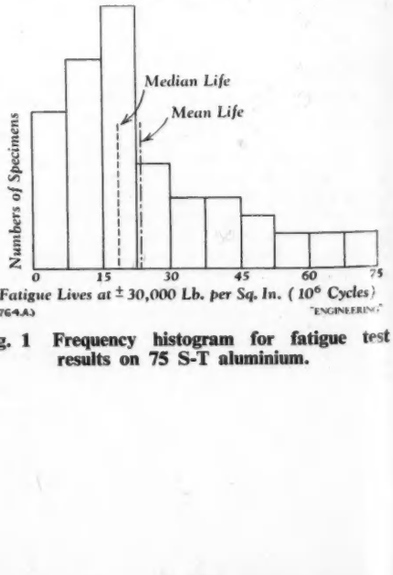


Fig. 1 Frequency histogram for fatigue test results on 75 S-T aluminium.

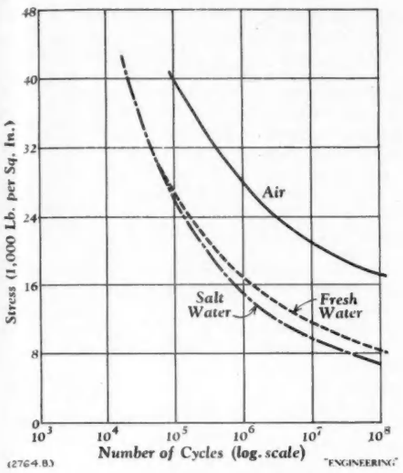


Fig. 2 Corrosion fatigue curves for Duralumin.

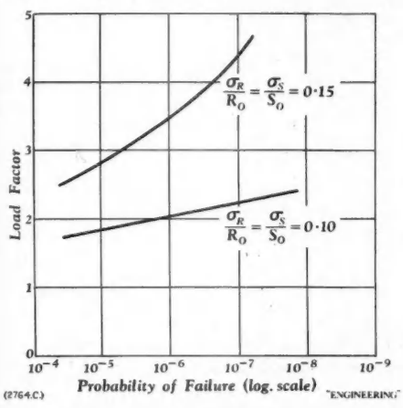


Fig. 3 Effect of change of load factor on probability of failure.

bar) the effect of creep is to reduce the peak thermal stress arising in the cycle and build up a residual stress of opposite sign. If allowance is made for the variation of viscosity with temperature, the peak thermal stress reached is still further decreased. Thus the effects of thermal cycles on the internal stresses in a structure may be very complex, quite apart from any induced metallurgical changes affecting the fatigue properties of the material of the structure.

CONCEPTS OF SAFETY

Modern probability theory has been brought to bear on the subject of structural safety by Freudenthal, working mainly in the field of civil engineering structures. A standard problem is the choice of load factor for a given probability of failure due to over-loading, assuming relevant statistics of wing loads and wing strengths are known. If these statistics are distributed normally, the whole problem is now reduced to a simple quadratic relation.

It is then possible to plot curves for load factor against the probability of failure for various values of the variances σ_R/R_0 and σ_S/S_0 where R_0 and S_0 are the means and σ_R and σ_S the standard deviations of strengths and loads respectively. Fig. 3 shows how rapidly the risk of structural failure can be cut down by an increase of load factor. What is not generally realised is the great change of risk that must occur before it becomes noticeable to the users of aeroplanes. Structural accidents occur seldom and form only a small proportion of the total accidents to a given aeroplane type; under service conditions, even in peace, the structural accident rate has to be doubled or trebled before the change is sensed by service crews.

In linking safety standards with economic efficiency the general approach is to ignore human risks and aim to design the structure in the most economical way, allowing for its finite life and the need for its replacement on failure. Thus the structure provided on this basis is the one that makes the total cost of its maintenance (by periodic replacement or repair) for its given purpose a minimum. Quite incidentally, such a structure will have a definite failure rate, determined by costs alone. It is convenient to cast the economic theory directly in terms of the probability of failure.

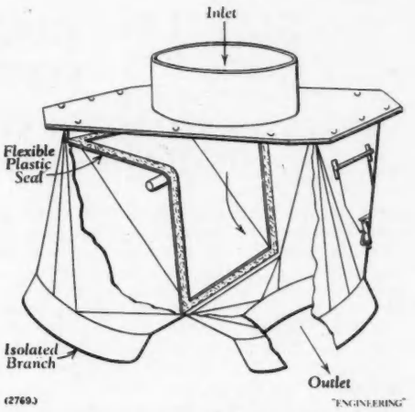
The economic approach has developed rapidly partly because nobody working in this field has yet seen an acceptable and rational way of handling the human-aspect of the safety problem. Recent large-scale accidents, however, have brought to mind an approach to this difficulty. When a small aeroplane crashes and its one or two passengers are killed it is regrettable, but even if due to structural failure, unless there is a rapid succession of such accidents, the public reaction is still small. When, however, a large civil aeroplane with some 50 passengers crashes, and the failure is clearly a structural one, the reaction is not only national but international. A second such accident brings such pressure to bear that the whole fleet of aeroplanes may be grounded. The overall effect, though not deliberately economic, can be measured in economic terms.

SAFETY MARGIN RELATED TO SIZE

Considering a small non-passenger carrying aeroplane A, a large civil aeroplane B, economic considerations based on the probability of failure suggest that, to satisfy public opinion, the structural accident rate for aeroplane B should be about one-tenth that for aeroplane A. In fact, however, there are commonly many more serious accidents to aeroplanes for non-structural than for structural reasons. Nevertheless, even when an attempt is made to allow for this, the demand, expressed by the analysis in economic terms, is still for a relative decrease of the structural risk, as between B and A, of at least 3 to 1. This order of change does not, of course, involve a correspondingly large increase of load factor for the large aeroplane; an increase of 10 per cent. or 20 per cent., appropriately applied, might cover the difference.

Civil engineers have for long been accustomed to provide somewhat greater margins of safety in cases where human life is peculiarly at stake or when the economic effects of a structural failure would be great. A committee of the Institution of Structural Engineers has reviewed such allowances so far as load factors are concerned, and tried to state them empirically in numerical terms. In other words, it has aimed to rationalise deliberate provision for the " seriousness " of a failure, whether measured in human or economic terms; and it is interesting that the allowances suggested, though not in the same form, cover a greater range than the " large airliner " reserve factor of 1·1 or 1·2 deduced by the economic-cum-probability argument just outlined. Since it is not possible to sense a change of aeronautical structural accident rate until it reaches roughly a 3 to 1 ratio, it may be that the probability of structural failure, as between a small non-passenger carrying aeroplane and a large airliner, should have a ratio of more nearly 10 to 1.

A practical approach at the present time would perhaps be to say that (assuming the airworthiness of current small aeroplanes is satisfactory) with large new civil airliners, particularly those with rather experimental features, every effort should be made to ensure that their probability of structural failure is less rather than greater than for the conventional small civil aircraft. To ensure this it would be necessary to expend more money, skill and time on structural calculations and proving tests. Sometimes too it may be wise to lower general stress levels, whether measured by a reserve factor or not, or to resort to a greater use of redundant structures to provide alternative load paths and so on. This, rather than a strictly numerical approach, is perhaps the wise way of stating the matter today.



K.C. two-way control valve for materials in bulk.

TWO-WAY CONTROL VALVE FOR BULK MATERIAL HANDLING

A problem frequently encountered in the control of bulk material handling is the difficulty of diverting the flow of material from one duct to another. To overcome this difficulty, Dallow Lambert and Company, Limited, Spalding-street, Leicester, have recently introduced a modified two-way valve for use in dust control systems.

The illustration above shows the new device which is identified as the K.C. Two-Way Control Valve. It can be used with all types of dusts, chippings, wood waste, etc., and will operate fitted in any position. Basically, the device consists of a sheet-metal Y-piece containing a metal chute which can be pivoted to direct the flow of gas and material as required.

The profile of the chute has been designed to present minimum resistance to the flow, the flow path through the valve being smooth and regular, thereby reducing any tendency for build-up of solids to occur in the valve. The branch of the valve isolated by the chute is effectively sealed by the chute being seated on a durable flexible plastics joint. Where fibrous materials are being handled, with the possibility of material clinging to the edge of the chute during change-over, the flexibility of the plastic joint enables a dust-tight seal to be maintained round the obstruction until the next change-over.

The mechanism for operating the valve is spring loaded and can be operated by either hand or remote control; it gives a rapid positive action which prevents the chute from taking up a position in which neither branch of the valve is sealed. All parts of the valve are readily accessible, and the chute pivot bearings are self lubricating and require no attention. The K.C. valve is made in a range of sizes to fit ducting from 4 in. to 22 in. in diameter.

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TESTING GRIT ARRESTERS

When the Government's Bill for Clean Air is on the Statute Book industrialists and factory owners will want some check on the efficiency of their smoke-abatement measures. A small dust-sampling cyclone has been produced by Nash and Thompson, Limited, Oakcroft Road, Tolworth, Surrey, to check the cleaned gases after they have passed through grit-arresting and dirt-removing plants. By drawing a known amount of flue gases through this cyclone at an approximate rate of 20 cub. ft. per minute, it is possible to extract 95 per cent. of all solid matter down to a particle size of about 2 microns. This flue gas can be drawn through by means of a small blower or steam extractor, and the flow measured by a single orifice plate and inclined pressure gauge. The cyclone is of silver-soldered brass construction, lead-tin dipped to prevent corrosion by flue gases of high sulphur content.

SIZE DISTRIBUTION IN FINE POWDERS

ANALYSER BASED ON STOKES' LAW OF FALL WITH CONTINUOUS GRAPHICAL RECORDING

Since many of the characteristics of powders are related to the size distribution of the particles, several methods have been devised for statistical analysis of the variation. These include microscopic counting, liquid sedimentation, elutriation, surface measurement and light or X-ray scattering. Some of these have specific disadvantages, and all of them are rather slow. An instrument has, however, been produced by the Sharples Corporation Research Laboratories, 424 West 4th-street, Bridgeport, Pa., U.S.A., which is claimed to carry out an analysis in a time as short as 15 minutes and not longer than three hours, giving the result as a continuous graph. This instrument is called the Micromerograph and is distributed in this country by Sharples Centrifuges, Limited, Tower House, Woodchester, Stroud, Gloucestershire. The complete equipment is illustrated in Fig. 1. It requires a headroom of 9 ft.

The principle on which the instrument is based is Stokes' law of fall which states that for particles of a given density, their rate of fall in air is a function of their diameter. In the instrument a sample of the powder is blown into a sedimentation column down which the particles fall at rates governed by their diameters, landing on a scale pan at the bottom. The rate of increase in weight of particles on the pan is therefore a measure of their size distribution. Slight differences in the time of fall due to the finite size of the initial particle cloud are rendered unimportant by the relatively great length (220 cm.) of the sedimentation column.

DISPERSING AND WEIGHING

The first operation that must be performed is the introduction of the separated particles of the powder sample into the top of the column. This is carried out in the feeder head shown diagrammatically in Fig. 2. The sample, weighing 0·1 gm., is placed in the sample holder and this is then clamped in position on top of the feeding head. A blast of dry compressed nitrogen from the pressure chamber is then admitted by the solenoid-operated firing valve, which blows the sample through the guide tubes into the de-agglomerator. This consists of a closely-fitting cone and socket, the clearance being adjustable. The clearance is set by the projecting lever which has a scale, calibrated in microns, and is adjusted to the nominal size of the powder being analysed. The de-agglomerator disperses the separate particles over the area of the sedimentation column, the dispersion forces being varied by altering the gas pressure and also the de-agglomerator opening.

At the foot of the column is the scale pan, shown in Fig. 3. As the particles accumulate on the pan, a slight rotation of the balance beam on its torsion suspension occurs. A sensing device incorporated in the balance applies a signal to the electronic system of the instrument which, in turn, applies a current to a restoring-force coil on the balance beam. The current required to keep the beam balanced is a continuous measure of the accumulated weight of powder on the balance pan.

The milliammeter of the moving-chart recorder is actuated by the same current as that which counter-balances the weight of the powder on the pan. The resulting chart is a record of accumulated weight against time. This chart is a continuous record that is visually available throughout the determination. When the chart line becomes straight, the determination is complete, although for many applications it is satisfactory to discontinue the run at an arbitrary time, at an arbitrary slope on the curve, or at some percentage of the total sedimentation.

For cleaning, the handle that makes the seal at the foot of the column is released, and the column is swung clear. At the back of the feeder head is a button which is pressed to blow clean the sample tray, the pipework and the de-agglomerator. The scale pan can be removed without the use of any tools and the accumulated powder cleaned off. In this way the instrument can be ready for a second sample in a very short time. The sedimentation column is made of aluminium insulated with a glass-fibre blanket. It is 85 in. long and has an internal diameter of 3½ in.

CHART CONVERSION

Since the times required for the various sizes of particle to fall are inversely proportional to the square of the particle diameter and to its density, the information given by the chart is a size distribution curve showing the percentage weight of particles smaller than any given diameter. A standard template is used to convert the time scale of the chart into a value which, divided by the square root of the density, will give the particle diameter in microns. Even this calculation can be eliminated by making special templates for each density. Thus, the operator need not have any special knowledge, for the action is automatic after the starting button (which operates the firing solenoid and is mounted above the recording chart) is pressed. The record shown in Fig. 4 is for a powder with a medium size-distribution. Actually, it was a sample of metallic tungsten which had been powdered to a maximum nominal size of 12 microns. The analysis showed that this had been achieved and that 50 per cent. of the particles (by weight) lay between 3·6 and 6·6 microns. This analysis occupied two hours.

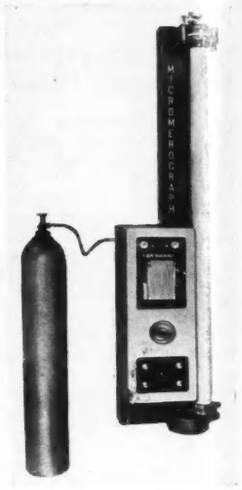

Fig. 1 Size distribution of particles in fine powders can be determined by the Micromerograph using unskilled labour. Particle sizes from 0·8 to 250 microns can be analysed.

HIGH STATISTICAL ACCURACY

The statistical accuracy of the Micromerograph is high due to the comparatively large sample utilised, in which there is an enormous number of particles. The instrument is capable of handling a large variety of materials and also a large particle-size range. The approximate upper and lower limits are given in the table which appears on the next page for materials with widely varying densities.

The Micromerograph is suitable for keeping the particle size distribution of powders within

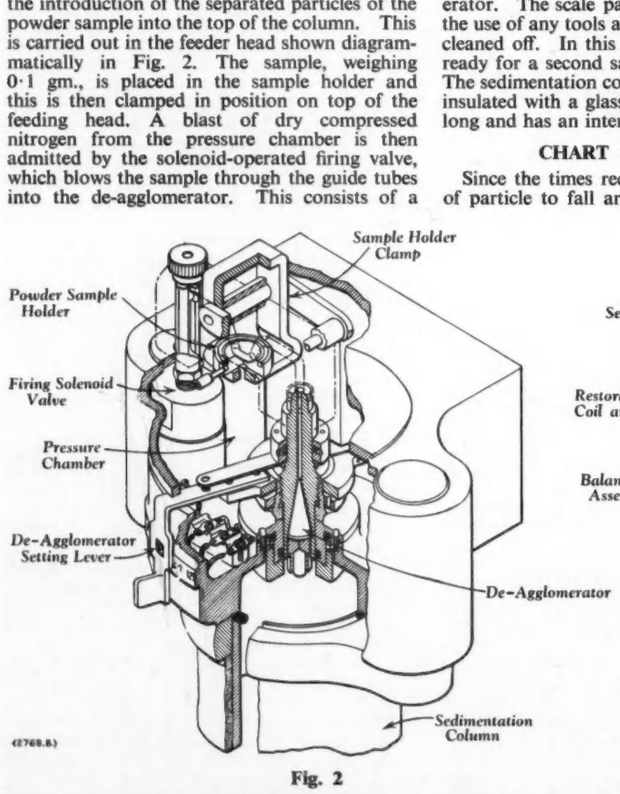

Fig. 2

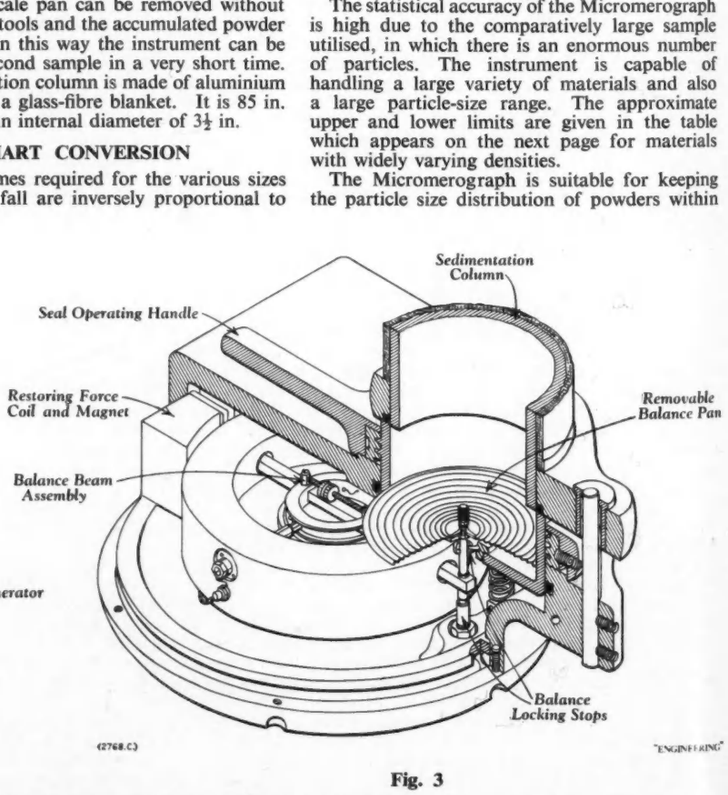

Fig. 3

Fig. 2 The sample of powder is blown from the holder through the de-agglomerator which disperses the particles. Fig. 3 The dispersed particles fall on the balance pan and equilibrium is restored automatically by a change in current in the restoring coil.

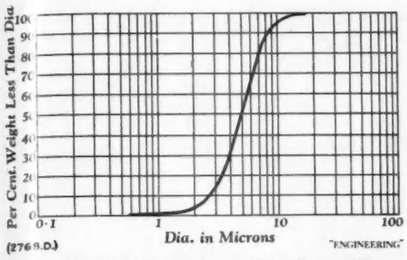

Fig. 4 The distribution by weight of the different sized particles can be obtained by applying a template to the chart. This is a typical result for a sample of metallic tungsten ground to nominal maximum of 12 microns.

safe or acceptable limits. Limits once having been established, non-technical operators can quickly check a size-distribution curve against a transparent overlay showing the area of acceptability. The chart and the derived particle size distribution curve form permanent records for future reference. The rapidity with which determinations can be made and the reproducibility of results can be very useful in research work. A floor area of 14 in. by 28 in. is required, and a ceiling height of not less than 9 ft.

Material	Density	Lower size limit	Upper size limit
Resin	1·3	3 microns	250 microns
Limestone ..	2·9	2 microns	170 microns
Nickel	8·9	1·2 microns	90 microns
Tungsten carbide	15·9	0·8 microns	70 microns

HORIZONTAL ENGINE FOR RAIL TRACTION

UNDERFLOOR UNITS OF 300 AND 450 B.H.P.

One of the most recent additions to the range of oil engines made by Davey, Paxman and Company, Limited, Colchester, is the ZH type, a horizontal flat engine for underfloor mounting. The normally-aspirated six-cylinder model has an output of 300 brake horse-power at 1,500 r.p.m., while the pressure-charged version produces 450 brake horse-power at the same speed. The former is shown in Fig. 1.

The engines have been designed for rail traction work and will fit vehicles built to the British loading gauge and also narrower ones, as for instance the 3 ft. 6 in. New Zealand lines. The overall dimensions are 8 ft. 5 in. long (over the turbo-blower), 5 ft. 2½ in. wide and 36 in. deep. Aluminium has been used to a large extent giving a dry weight of 5,100 lb. or about 13 lb. per brake horse-power for the pressure-charged model. Fuel pump, valve-gear, filter and timing gear are all accessible from the sides at rail level or from a pit. The engine can be lowered from its mountings (after disconnecting the drive) and removed sideways from below the vehicle.

The cylinders are 7 in. bore and the stroke is 7½ in. At 1,500 r.p.m. this gives a piston speed of 1,935 ft. per minute. The pistons are cast aluminium alloy and run in replaceable cast-iron "wet" liners. There is a central combustion chamber in the piston crown and three compression and two scraper rings are fitted. The gudgeon pin is fully floating and runs in a silicon-bronze bush in the little end. Following the firm's present practice, four valves per cylinder are used, with aluminium-bronze seats. The gear-driving camshaft is below the cylinders and runs in an oil bath, operating the valves through push-rods and rocker gear. The cylinder heads are cast in blocks of three and carry on them the rocker gear. Tappet clearance is controlled by screw-type adjusters which can be reached from the side.

The big ends of the stamped connecting rods are split at an angle to facilitate removal; lead-flashed copper-lead bearings are used. The seven main bearings are also copper-lead and the crankshaft is steel. A vibration damper is fitted on the free end, outside the crankcase.

Oil for lubrication is handled by two gear-type pumps, carried externally and driven from the engine. The low-pressure pump passes the oil through the cooling radiator and then to a filter while the high-pressure one feeds the main gallery through a full-flow felt-element Vokes filter which has a safety valve set at 80 lb. per square inch. This arrangement avoids the difficulties encountered when there is high-pressure oil in the radiator, and also allows the latter to be fitted with an independent relief valve. Oil pressure in the main gallery is kept at 50 lb. per square inch by another relief valve. Forced lubrication is supplied to main and big-end bearings, to the camshaft and, intermittently, to the rocker gear via the camshaft.

A centrifugal water pump is gear driven from the free end of the crankshaft. Water is fed direct to the underside of the engine through a flexible connection and thence to the manifold which is integral with the main crankcase casting. A by-pass valve, thermostatically controlled by bellows units, is incorporated in the jacket system and controls the water temperature to between 150 and 160 deg. F.

Direct fuel injection is used with a C.A.V. monobloc pump supported on the bottom crankcase cover. A plunger boost pump supplies fuel through a filter. Either a mechanical or servo governor is fitted for speed control and there is also an overspeed stop mechanism. Conventional electric starting is used. Performance curves are given in Figs. 2 and 3.

To suit the usual type of underframe or subframe, a four-point mounting is used employing Vibro-insulators supplied by the British Tyre and Rubber Company, Limited, Herga House, Vincent-square, London, S.W.1, which can be seen in the illustration. The rear mountings are secured to a steel housing bolted to the engine

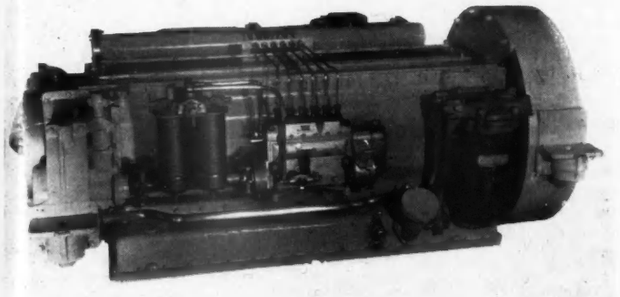

Fig. 1 Side view of the unsupercharged engine which develops 300 b.h.p. at 1,500 r.p.m.

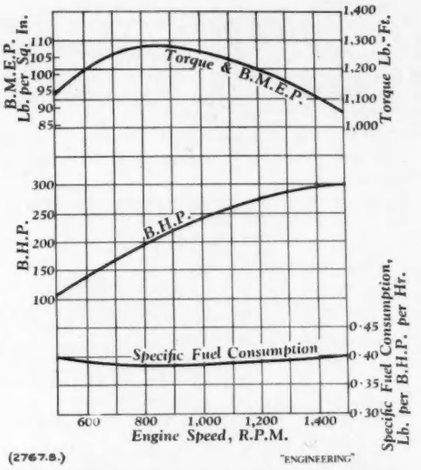

Fig. 2 Performance curves for the unsupercharged engine governed to 88·5 lb. per square inch b.m.e.p.

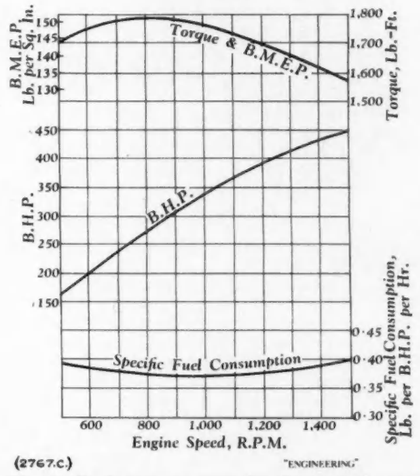

Fig. 3 Performance curves for the supercharged engine governed to give 450 b.h.p. at 1,500 r.p.m. (one-hour rating).

framing, which is suitable for an overhung flange-mounted generator, a traction-type fluid coupling or a simple friction-clutch and carden shaft according to the type of transmission chosen.

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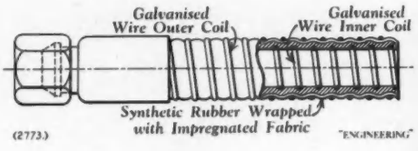
BITUMEN-PROTECTED METAL ROOFING SHEETS

Absence of Fire Risk

An investigation has recently been conducted by the Joint Fire Research Organisation at Boreham Wood into the fire risk attendant upon the use of bitumen-protected metal sheets for roofing. In particular, the investigation was made at the request of Cellactite and British Uralite, Limited, Whitshall-place, Gravesend, Kent, who supplied a number of their Cellactite protected-metal sheets for the test.

The suggestion had been made that in a fire the bitumen contained in this type of material would soften and finally ignite, dropping burning embers on to anything below. Samples of the sheets were however subjected to stringent conditions such as might reasonably be encountered in a fire and—as previous site experience has shown—there was no tendency for the lateral spread of flame and no flaming drops were formed. The conclusion is that, for this particular product, the supposed fire risk from melting bitumen was negligible, presumably because the bitumen was firmly held by the asbestos ingredient even at the temperatures involved.



HIGH-PRESSURE FLEXIBLE TUBING

The process used for the manufacture of flexible tubing by Petro-Flex, Limited, Watford, whose products are marketed by Smiths Industrial Instruments, Limited, Chronos Works, London, N.W.2, produces a high-pressure tube with a nearly smooth bore. The tubing is an extrusion of synthetic rubber, which is not affected by the action of water, petrol, gases, vegetable or mineral oils or a variety of industrial solvents. The temperature range is from −40 deg. C. to +80 deg. C. and the maximum working pressure 150 lb. per square inch.

The basic material is either Neoprene or Polysar, which is compounded with carbon black, a vulcaniser, an accelerator, and other ingredients. The compounding mill has two rollers running in opposite directions and at different speeds, producing a tearing as well as a crushing action. The compounded mixture is passed through a second mill to increase plasticity before extrusion. The extruder can be fitted with different dies for varying tube thickness and internal diameter. The extruded tube is fed over a mandrel, the external diameter of which is the required bore of the tube, and round which a coil of galvanised iron wire has been wrapped. Impregnated canvas is wound over the tube, and a further coil of wire is wrapped round the canvas. Care is taken that the turns of wire of the outer coil run between the turns of the inner coil, as the diagram shows. The complete tube is vulcanised, and the inner and outer coils of wire become embedded in the synthetic rubber, so that the tube has a practically smooth bore. After vulcanising the tube is cut into required lengths, and the end fittings, of which more than 1,000 types are available, are fixed in place. This type of tubing is made in lengths up to 15 ft., greater lengths being coupled, and is produced in bores from $\frac{1}{16}$ in. to $1\frac{1}{2}$ in. The bending radius varies from $1\frac{1}{2}$ in. for the $\frac{1}{16}$-in. bore to 6 in. for the $1\frac{1}{2}$-in. bore. Weight per foot run varies from $3\frac{1}{2}$ oz. to 11 oz., and flow per minute with 1-ft. head varies from $\frac{3}{4}$ gal. to 38 gals.

For low-pressure applications the wire reinforcement is not necessary. The tube is vulcanised immediately after extrusion, and can then be used as it is, or covered with galvanised iron, phosphor bronze or tinned copper braiding.

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LAUNCHES AND TRIAL TRIPS

S.S. "BRUIN."—Single-screw cargo vessel, built and engined by Hall, Russell & Co., Ltd., Aberdeen, for A/S Jelolinjen, Oslo, Norway. Main dimensions: 265 ft. between perpendiculars by 44 ft. by 19 ft. 3 in. to main deck; deadweight capacity, about 2,500 tons on a draught of 16 ft. 10 in. Hall Russell-Fredriksstad double compound four-cylinder steam engine. Steam supplied by two oil-fired cylindrical boilers. Launch, February 24.

M.S. "THORDIS."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Ltd., Gothenburg, Sweden, for Tönnevolds Rederi A/S, Grimstad, Norway. Main dimensions: 550 ft. overall by 60 ft. by 39 ft. 3 in.; deadweight capacity, about 17,400 tons on a draught of 30 ft. 2 in. Götaverken nine-cylinder single-acting two-stroke Diesel engine, developing 6,750 b.h.p. at 112 r.p.m. Loaded speed, about 15 knots. Delivered, February 24.

S.S. "NOWSHERA."—Single-screw cargo vessel, built and engined by Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, for the British India Steam Navigation Co., Ltd., London, E.C.3. Second of a new series of ships for these owners. Main dimensions: 514 ft. overall by 67 ft. by 41 ft. 9 in.; gross tonnage, 8,516; deadweight capacity, 10,250 tons. Parsons geared steam turbines developing 10,250 s.h.p. Speed on trials exceeded 18 knots. Trial trip, February 24 and 25.

H.M.S. "RENDLESHAM."—Inshore minesweeper, built by Brooke Marine Ltd., Lowestoft. One of a group of these vessels being constructed in the United Kingdom for N.A.T.O. nations under the United States Off-Shore Procurement Programme. They have a length of 106 ft. 5 in., a breadth of 20 ft. 6 in., are of all-wood construction, and are designed to operate in shallow waters. Launch, February 25.

M.S. "DANALAND."—Single-screw oil tanker, built and engined by the Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, for the Rederiaktiebolaget Motortank (a member of the Broström group of companies), Gothenburg, Sweden. Sister ship of the M.S. Markland, constructed for the same owners. Main dimensions: 526 ft. between perpendiculars by 69 ft. 9 in. by 39 ft. 3 in.; deadweight capacity, 17,750 tons on a draught of 30 ft. $4\frac{1}{4}$ in.; oil-tank capacity, 835,232 cub. ft. B. and W. seven-cylinder two-stroke Diesel engine, developing about 9,350 i.h.p. at 115 r.p.m. and arranged for operating on heavy oil. Speed, $15\frac{1}{4}$ knots fully loaded. Delivered March 1.

M.S. "CONCORDIA FJORD."—Single-screw cargo vessel, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Skibs A/S Hilda Knudsen, Haugesund, Norway. Main dimensions: 462 ft. overall by 61 ft. 6 in. by 38 ft.; deadweight capacity, 8,200 tons on a draugh of 26 ft. Götaverken eight-cylinder single-acting two-stroke Diesel engine, developing 7,300 b.h.p. at 112 r.p.m. Speed, 17 knots fully loaded. Launch, March 8.

S.S. "BARANA."—Twin-screw tug, built and engined by John I. Thornycroft & Co., Ltd., Southampton, to the order of the Crown Agents for Oversea Governments, London, S.W.1, for the Government of Ceylon. Main dimensions: 122 ft. 6 in. overall by 31 ft. 6 in. by 14 ft. 6 in.; draught, 13 ft.; gross tonnage, about 350; static pull, approximately, 18 tons. Two triple-expansion reciprocating steam engines together developing a maximum of 1,400 i.h.p. at 125 r.p.m. Steam supplied by two oil-fired Scotch cylindrical boilers. Speed, about 11 knots. Launch, March 9.

M.S. "PHAROS."—Twin-screw lighthouse tender, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the Commissioners of Northern Lighthouses, Edinburgh. Main dimensions: 235 ft. between perpendiculars by 40 ft. by 19 ft. 6 in.; service draught, 13 ft. Two seven-cylinder single-acting two-stroke marine Diesel engines, each developing 985 b.h.p. at 220 r.p.m., constructed by British Polar Engines Ltd., Glasgow. Speed, 14 knots. Launch, March 9.

M.S. "RANWORTH QUEEN."—Single-screw trawler, built by John Lewis and Sons, Ltd., Aberdeen, for Talisman Trawlers Ltd., Lowestoft. Last of a series of four vessels for these owners. Main dimensions: 113 ft. 6 in. overall by 22 ft. by 10 ft. 9 in. Six-cylinder Diesel engine, developing 440 b.h.p. at 300 r.p.m., constructed by Crossley Brothers Ltd., Manchester. Trial trip, March 9.

The new measuring room at the Coventry works of Alfred Herbert, Limited, serves the whole of the Company's works, and also acts as a demonstration room for their range of instruments.

MEASURING AND INSPECTION

New Gauge Room at the Works of Alfred Herbert Limited

Alfred Herbert, Limited, Coventry, have had a measuring room in use at their works for about 25 years. Recently, arrangements have been made to co-operate with Taylor, Taylor and Hobson, Limited, the Coventry Gauge and Tool Company, Limited, and the Pitter Gauge and Precision Tool Company, Limited, in the sale of their precision measuring equipment. Alfred Herbert, Limited, have for some years been distributing the products of Hilger and Watts Limited, and the Sigma Instrument Company, Limited, and the instruments and technical services of six organisations are now available to the Coventry firm.

The opportunity afforded by these new arrangements has therefore been taken to equip a new measuring room at Coventry which is A.I.D. approved and will have a three-fold purpose. In the first place it will serve as the central gauge and measuring room for the Alfred Herbert works, and will be responsible for checking all the routine measuring equipment used in the manufacture of the firm's range of machine tools. Secondly, it will act as a demonstration room where the products of the six firms mentioned can be seen in use under normal working conditions. Thirdly, it will be used as a clearing-house to solve customers' measuring and gauging problems and to develop methods and techniques for using instruments for specific applications. Because of the wide range of equipment available and the large number of problems it handles, the measuring room will also be able to survey the field of industrial metrology generally, and to suggest possible new developments from the experience gained during the use of the instruments.

As will be seen from the accompanying illustration, the measuring room is a large, well-lighted building, with ample space for a wide range of instruments. The left-hand side, as seen from the entrance, is mainly devoted to gauging, mechanically, electrically and pneumatically, and the right-hand side of the room houses a large collection of optical projectors, leading up to the largest of the Hilger and Watts range, which can be seen in the foreground. In the centre of the room there are two rows of benches for displaying instruments of many different types, including measuring equipment, comparators, auto-collimators, and interferometers. Every instrument is in full working order, in fact all of them are used as required by the needs of the works and for investigating problems submitted by customers.

ELECTRICAL ENGINEERS EXHIBITION

Concluded from page 303

The formal opening of the Electrical Engineers Exhibition was carried out by Lord Citrine on March 15. In the opening speech he recalled the growth of the exhibition since 1952, and congratulated the industry on its achievement. Lord Citrine said that the increased demand for electrical goods was reflected by the record of the supply industry where the maximum load carried had increased by nearly 75 per cent. in seven years. He also mentioned the plans for the atomic power stations. Turning to another side, Lord Citrine said that the electrical industry now employed over 900,000 persons, almost double the number that were engaged in it just after the war. He wished great success to the exhibition and its organisers, the Association of Supervising Electrical Engineers.

Following the opening, awards were made for the most outstanding exhibits. That for the industrial division was accorded to the Record Electrical Company, Limited, for their clip-on recorder (described in the earlier article) and the one for the domestic division to Ferranti, Limited, for their Fridge-heater, which is described in the present article.

CONTACTOR FOR QUICK SERVICING

Allen West and Company, Limited, Brighton, were displaying samples from their range of heavy and light switchgear and contactor gear. Among the latter was a recently introduced starter or circuit breaker fitted with a plug-in contactor unit which can be removed for servicing. By lifting two latches, the entire mechanism can be removed giving free access to the contacts for cleaning. In addition two other catches can be rotated allowing the magnet to be swung forward clear of the front of the contacts. Removal and replacement occupy a matter of seconds only, reducing shut-down time to a minimum. The starter, known as the PSC4D, has three-phase tripping with time lags controlled by oil dash-pots. The tripping current can be set from 25 per cent. overload upwards, and restrainers can be fitted for starting currents. Models, all of which are fitted with isolating switches, are available for motors up to 12½ h.p., 650 volts, three phase. Also shown on the stand was a control panel with sequence interlocking for a materials handling plant.

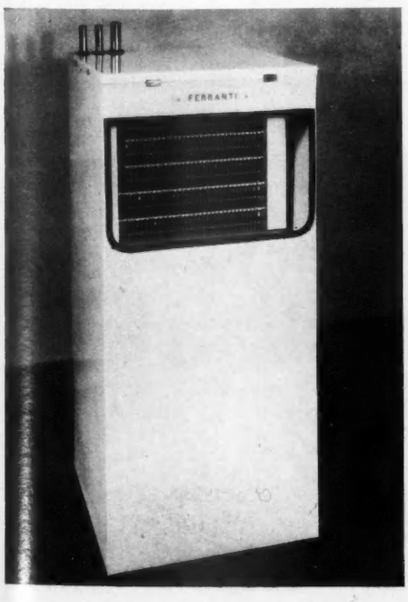


Fig. 5 The heat-pump unit shown here can be connected to a standard domestic hot-water system, giving water at 140 deg. F. and cooling a 120-cub. ft. larder by about 20 deg. F.

FLAME-PROOF TRACTION MOTORS

Electric motors in sizes up to 10 h.p. were exhibited by Small Electric Motors, Limited, Beckenham, Kent. Buxton certificates have recently been obtained for a range of flame-proof traction motors, of which examples were on show. One model had a one-hour rating of 9·4 h.p. at 1,500 r.p.m., 67 volts, 130 amperes. Class B insulation is used. Other motors shown included totally-enclosed fan-cooled types up to 10 h.p. at 440 volts, and many fractional horse-power machines.

REFRIGERATOR-HEATER

Among the domestic appliances on the stand of Ferranti, Limited, Hollinwood, Lancashire, was their recently produced Fridge-Heater, shown in Fig. 5. This is a heat-pump unit for water heating and larder cooling. It is designed for connecting to a normal domestic hot-water system with a storage tank on one of the upper floors. The unit itself measures 3 ft. high by 16 in. wide and 16 in. deep. Thermostat control limits the temperature of the water in the storage tank to 140 deg. F., the tank size being chosen for the household concerned. On the average, the heat extracted from the larder when no hot water is being used lies between 6,000 and 10,000 B.Th.U. per day. If hot water is being withdrawn, an additional 800 B.Th.U. will be extracted for each gallon. With a larder of 96 cub. ft. capacity, the temperature of the air below the level of the lid of the machine is about 15 to 20 deg. F. below the outside temperature. Ice can be made in a tray at the top of the machine and there is room for a few milk bottles in front of the evaporator. The firm were also showing a wide range of their other products including transformers (some with Class H insulation), meters, a digital computer and a high-speed tape reader.

LOW-VOLTAGE SWITCHGEAR

Several firms exhibited low-voltage switchgear and distribution boards. Among them were Astral Switchgear Limited, Alma-road, Enfield, Middlesex, who were showing for the first time at the exhibition a range of fuse switches for 660-volt supplies with ratings up to 300 amperes. These are mounted in cast aluminium housings and have been short-circuited tested at 35 MVA.

J. A. Crabtree and Company, Limited, Lincoln Works, Walsall, were another firm showing switches and starter gear. Their exhibits included a new range of limit switches, available with a variety of forms of operating head, and including patterns for both snap and slow operation. A miniature control board was exhibited by Ferguson Pailin, Limited, Manchester, 11, which operated five circuits. It is illustrated in Fig. 7. Control and indicator switches are built into the circuit diagram so that the condition can be seen at any time. Warning lights are also included.

Another range of high-rupturing-capacity fuses which made its first appearance at this exhibition, was that now being made by Parmiter, Hope and Sugden Limited, Longsight, Manchester 12. Known as the Aeroflex range, these have ceramic bodies and can be rewired, though it is recommended that this should be done at the maker's works. The rupturing capacity is 46 kA, equivalent to 35 MVA on a three-phase circuit, and the fusing factor is 1·25.

HIGH-TEMPERATURE ALLOY

Henry Wiggin and Company, Limited, Thames House, London, W.1, were showing, among their general range of products, a new grade of nickel-chromium alloy for high-temperature furnace resistors. It will be known as Brightray H and is intended for operation in the range

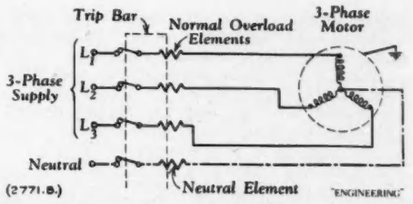


Fig. 6. Circuit for comprehensive protection of a three-phase motor.

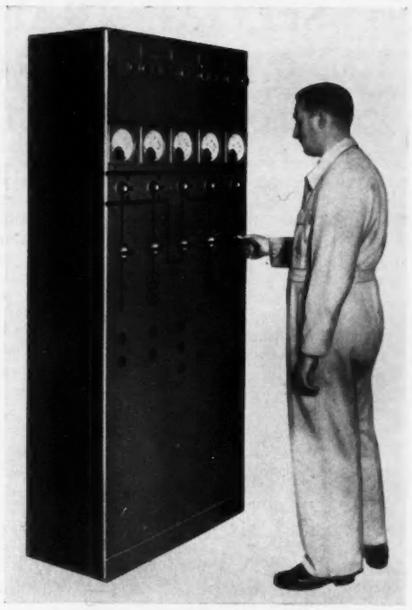


Fig. 7 Miniature control panel with indicating control switches.

1,100 to 1,250 deg. C. Laboratory tests on a strip 0·88 mm. thick by 14 mm. wide gave a life of over 1,000 hours at 1,250 deg. C. in air. The specific resistance varies from about 126 michrohms per square centimetre per centimetre at 20 deg. C. to about 130 at 500 deg. C. and falls to 124 at 1,300 deg. C. It does not become brittle during service.

TAP-CHANGING GEAR

Recently added to the range of switchgear made by the Brush Electrical Engineering Company, Limited, Loughborough, is an "on-load" tap-changer, an example of which was on show. The gear is built for 33-kV equipment and there are two models with ratings of 250 amperes or 400 amperes. The reactor principle is used in the transitional stages between tappings, the reactors being fully rated. Provision is made for 21 tapping positions.

Selector and divertor switches are mounted in separate tanks, one above the other. The selector contacts are mounted on a Permali bar, but are so arranged that contact pressure is taken by a fixed collector ring thereby removing load from the bar. Rotation is by a Geneva-wheel mechanism. The gear can be controlled automatically or by hand, from either a local or a remote station. Emergency hand operating gear is fitted. The firm were also showing samples from ranges of circuit-breakers, motors and transformers.

MOTOR PROTECTION SYSTEM

The English Electric Company, Limited, Marconi House, Strand, London, W.C.2, were exhibiting products from eleven of their departments, including domestic appliances such as cookers and driers. For the remote control of boiler dampers there was an electrically-operated linear actuator, and another demonstration was of a comprehensive protection scheme for three-phase fractional horse-power motors, for which

patent application has been made. The circuit is shown in the diagram, Fig. 6. The system is based on the fact that any unbalance in the circuit of a three-phase star-connected motor will produce a voltage between the neutral point of the motor windings and the supply neutral. This applies whether the condition is due either to any unbalance of the supply voltage or to a winding fault causing an unbalance in winding impedance and thus unbalanced phase currents. Hence, the addition of an overload coil in the neutral line will trip the starter when an unbalance occurs. Thus the only alteration to a standard starter is this extra coil; its presence does not affect normal earthing arrangements. For a single motor, the star-point neutral is connected to the supply neutral, but where there are more than three motors in the installation, it is preferable that the neutral lines, after passing through the overload coil, should be connected together and not to the supply neutral. This reduces the effect of external influences.

SPECIAL TRAINS FOR LAYING CABLES THROUGH TUNNEL

NEW COMMUNICATION LINES UNDER THE SEVERN

An interesting piece of signal and communications engineering was carried out on Sunday, January 30, 1955, under the direction of the Signal Engineer of the Western Region, British Railways, Mr. A. W. Woodbridge, when three new cables were laid from the eastern end of the Severn tunnel, which is 4 miles 628 yards long, to the Sudbrook shaft, on the western bank of the river, up which the route is continued to reach the end locations overground.

Electrical communication had to be provided through the tunnel for block telegraph and other purposes at its opening at the end of 1886, but not until 1913 was a multi-core cable, which was lead sheathed and armoured, laid throughout its length. (There had, however, been a smaller cable along the underwater portion only of the tunnel, subsequently recovered.) In 1928, a Post Office cable was carried along the same route. This was abandoned in 1939 when three new ones were run, also for the Post Office. In 1944 the then Great Western Railway laid a 28-pair 40-lb. lead sheathed and single-wire armoured cable, four pairs loaded for carrier and four for audio frequencies, in connection with what was called the "green line" conference scheme, which linked all Divisions of the railway to a switchboard at Paddington, with inter-dialling facilities. The Chief Operating Superintendent in London was able to dial all Divisions simultaneously. New three-way cast-iron supporting hooks, with specially-protected bolts, also were provided. In 1951, in connection with the new television station at Wenvoe, a fourth Post Office cable was run to and up the Sudbrook shaft, with an additional route of three-way hooks, in this case themselves specially protected by "Denso" tape against corrosive effects, always particularly troublesome in such a long steam-worked tunnel. There were then two three-way runs, both on the down side of the line.

RENEWALS REQUIRED

In 1952 the Signal Engineer made a detailed inspection of all cables and supports and found the upper—Post Office—run to be in excellent condition, hooks included, but that the lower called for considerable attention. One cable was much rusted and numbers of hooks demanded immediate renewal, while others would have to be replaced within a few years. After consultation with the Chief Civil Engineer, and taking account of the experience gained in the course of maintenance and the results of chemical and other tests made on certain items of equipment recovered from the tunnel, it was decided to instal a new run of three cables on protected hooks on the up side of the line for the 2 miles 54 chains from the eastern mouth of the tunnel, not far from Pilning, to the Sudbrook shaft. The 4,700 hooks needed were fitted on four Sundays in January, 1954.

An order was placed with British Insulated Callender's Cables Limited for the cables:—(*a*) a 12-core 0·164-in. 660-volt paper-insulated lead-covered cable (of mass impregnated non-drying type in the Sudbrook shaft); (*b*) an eight-pair 40-lb. quad carrier; (*c*) an eight-pair 40-lb. quad carrier plus 28-pair 40-lb. quad audio, the latter pairs loaded for audio frequencies, all with a specially heavy protective covering over the lead sheath, formed of two layers of impregnated paper, impregnated cotton and hessian, single-wire armouring, two layers of rubber between P.V.C. and, finally, two layers of hessian. These new cables would provide not only for existing signalling and communications requirements but afford facilities for developing the latter on the "carrier" principle.

The work of laying was entrusted to British Insulated Callender's Construction Company, Limited, with Mr. C. A. E. Crick, District Engineer, Bristol, in charge, in association with the railway staff.

CABLES JOINTED BEFORE LAYING

It is not easy to get the time required for work of this kind, the number of Sundays available and the hours in each being limited by many considerations. It is difficult also to carry out cable jointing and similar operations in a tunnel, and it was decided to effect all such work beforehand and lay the cables complete, ready to function. Fifteen flat so-called "borail" wagons with screw couplings were obtained from the London Midland Region and used to bring the cables to Pilning. The drums were placed in correct sequence on them and marked to denote the order of the various lengths in the tunnel. At Pilning the wagons were fitted with overlapping staging and electric light standards, made at Swindon, and marshalled into three trains, each with a box van containing generating equipment, guards' vans and, in the case of the third train laying the heaviest cable, a drilling plant for dealing with certain bracket fixings to be attached to the tunnel wall. The cables were undrummed and laid out in figure of eight formation, 1,000 yd. per wagon and pre-jointed and fitted with loading coils (Figs. 1 and 3). Diesel shunting engines were used, to eliminate smoke and steam and allow of close slow-speed regulation.

Very close co-operation was required between

Fig. 3 Showing a joint in one of the cables.

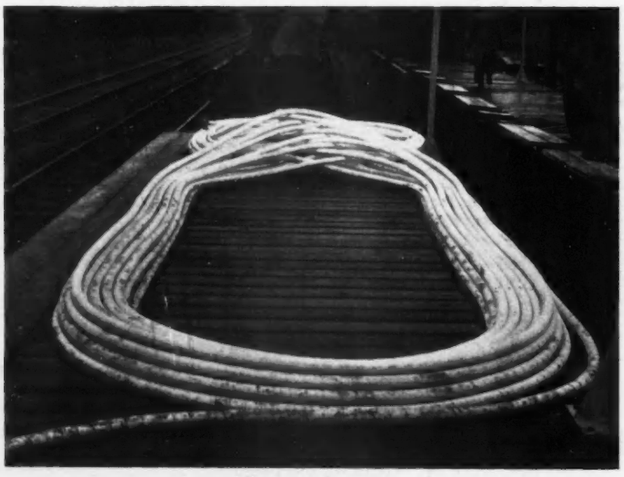


Fig. 1 A cable laid out on a wagon, showing special wide staging constructed to accommodate it.

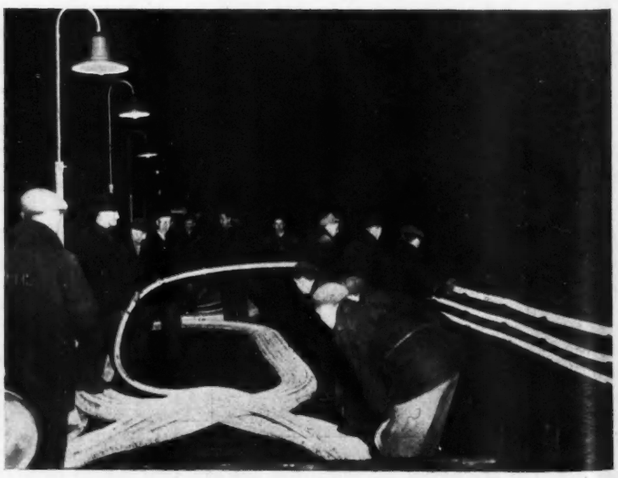


Fig. 2 Paying out the third and heaviest cable as the train is moved slowly through the tunnel.

the Signal Engineer's, Chief Civil Engineer's and Operating Departments, in consultation with several others, in organising arrangements for paying out the cables (Fig. 2). These were carefully rehearsed on January 19, except that no movement into the tunnel was made. Operation of the trains on the actual day was regulated by a special code of whistle and hand-lamp signals, as an emergency stop might be required at any moment, and certain stated stops were made by each one. The work occupied the line from about 5 a.m. to about 3 p.m. and was carried through without incident of any kind. Mr. Paul G. Jacobs, Assistant to Signal Engineer (New Works) was in charge for Mr. A. W. Woodbridge. On a subsequent Sunday the superseded cables were recovered. They were 10 miles long and weighed 110 tons.

DE-BURRING MACHINE

GEARS CLEANED BY ROTATING WIRE BRUSHES

To remove the burrs which remain on gear teeth after hobbing, a machine incorporating four rotary wire brushes and employing a cyclic oscillating action has been developed by the Elgro Machine Tool Company, Limited, a subsidiary of Gem Brushes (Luson), Limited, Minerva-road, Park Royal, London, N.W.10. Known as the Elgro automatic gear brushing machine, it has been designed to replace the costly and tedious process of filing burrs by hand in cases where gears of constant size are produced in considerable numbers.

The danger of inadvertently marking a gear and thus causing it to run noisily is particularly acute when hand filing is used for burr removal, and there is consequently a tendency for the number of rejects to be high. Moreover, the hand process is a comparatively lengthy one, especially with gears of more than a few teeth. It has also been observed that in certain brushing methods applied hitherto, the effect has been to bend the burr backwards and forwards rather than remove it cleanly; as a result, a minor burr has been left on the contact face of the gear tooth. It is in view of these considerations that the Elgro machine has been conceived, and the makers state that it performs automatically all the operations involved in cleaning gears prior to the finishing process, thereby dispensing with hand labour in this phase of production.

The machine, which is shown in the accompanying illustration, incorporates a central oscillating spindle upon which the gear is mounted and locked in position by means of a self-clamping mandrel. Plungers embodied in the mandrel emerge radially and grip the inner face of the gear, while in addition a pivoted latch is inserted between two adjacent teeth to prevent rotation. Surrounding the spindle are four rotary wire brushes, shown in the illustration with their axes disposed horizontally in slightly off-set radial positions; they are, however, capable of various translations and rotations. Each brush is driven by a separate motor at speeds which are steplessly variable and can be adjusted to suit the material of which the gear is made.

CYCLIC OSCILLATION OF MANDREL SPINDLE

The eccentric spindle oscillation is effected by means of a pinion mating with an internal gear and travelling round within it. The pinion has one tooth less than the internal gear and thus a relative rotational displacement corresponding to the lag of one tooth takes place every revolution. Up to 25 oscillations can be performed during each complete working cycle, the length of which can be controlled to include the number required; provision for more than 25 oscillations may be made if necessary. When all burrs have been removed from the gear, it is automatically lifted clear of the brushes; this vertical motion of the spindle is achieved by means of a hydraulic mechanism.

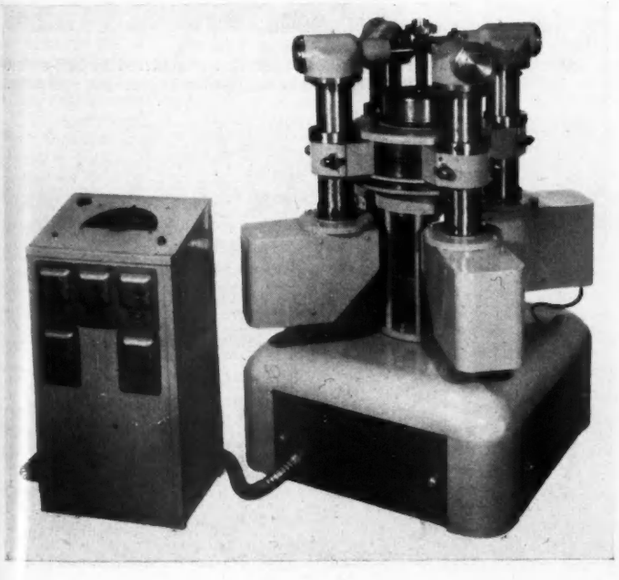
The effect of the oscillating action is to guide the gear in such a manner that each of the brushes passes into the recess between two teeth: firstly, along the edge of one tooth, then across the root, and finally out again via the edge of the second tooth. In this way the burrs are removed evenly and cleanly.

Each recess may during the working cycle be entered by either one or two brushes, and the number of brush entries, the brush speed and the timing of the process are set to suit the metal from which the gear is cut. Should the brush speed be too high, metal flow may occur, but this can easily be avoided if adjustments are correctly made. Incidentally, the machine can also be set to chamfer the tooth tip, thus giving the necessary tip relief and eliminating an additional operation often performed separately on a lathe.

ELECTRONIC CONTROL

The makers believe that in general, depending on the type of gear and its material, the machine will effect a reduction of approximately 66 per cent. in the time required for de-burring. Moreover, it is estimated that the average life of a set of brushes between replacements is half a day, in which time the machine will complete the de-burring of some 300 gears. However, by adjustments to the centre distances of the brushes their usefulness can be indefinitely extended. It must be emphasised that these figures vary considerably with the nature of the gears under treatment.

The machine incorporates electronic controls housed in a separate cabinet. It is designed primarily for use where gears are made in quantity, as in the aircraft and automobile industries, and is suitable for introduction into existing production lines. It may be adapted for all types of gear up to 2 ft. in diameter, and change-overs may be easily effected by substitution of various spindle assemblies, and other standard equipment.



Burrs which remain on gear teeth after hobbing may be removed by the Elgro automatic gear brushing machine which incorporates four rotary brushes and employs a cyclic oscillating action.

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Storage space can be hired in the bomb-proof underground depository that has been constructed at Neston.

RECORD STORAGE

Underground Depository for General Use

There has recently been constructed at Neston in Wiltshire, an underground depository for the storage of records, which is claimed to be proof against damage even by nuclear weapons. The promoters of the scheme are Wansdyke Security Limited, 1 Lincolns-Inn Fields, London, W.C.2, who will lease space in the depository to firms or institutions.

The storage space has been obtained by enlarging an old stone mine about 100 ft. deep., the cover being largely Purbeck marble. Gallerys have been extended and air-conditioning plant installed. The roof has been strengthened with reinforced-concrete piers and steel joists. The only entrance to the main gallery is through an anti-blowpipe steel door with burglar alarms communicating directly to police headquarters. There are uniformed security guards continuously on duty. The photograph reproduced above shows the entrance to one of the strong rooms.

Standard steel lockers, constructed by Chubb and Son's Lock and Safe Company, with separate keys, are provided for the storage of micro-film records, both 16- and 35-mm. sizes There are also private vaults in the main gallery. In addition, strong rooms have been constructed for the storage of deed boxes or other containers, and there is space beyond the main gallery which can be developed to suit tenants' special requirements.

(a) (b) (c)

Illustration (a) shows the "wire-drawing" or "guttering" of an austenitic steel valve when used in a Diesel engine burning boiler oil. This leads to severe burning of the valve rim in (b). The Brightray-coated valve in (c) has operated for twice as long as the valve shown in (b), and the deposit of fuel ash can be easily removed.

RUNNING DIESEL ENGINES ON BOILER OIL

Corrosion-Resistant Valves Needed

Tests on the use of boiler oils in Diesel engines were carried out recently in the experimental department of Mirrlees, Bickerton and Day, Limited, Hazel Grove, Stockport. The engine used was a Mirrlees 621-b.h.p. three-cylinder turbo-supercharged prototype of the K range. The advantage of using boiler oil is economic, because a 1,000-seconds boiler oil costs about 40 per cent. less than gas oil, and a 3,500-seconds oil is still cheaper. In the tests, boiler oils with viscosities of 220, 950, 3,500 and 6,000 seconds (Redwood 1 at 100 deg. F.) were compared with two gas oils of 37 and 40 seconds viscosity.

Successful operation of the experimental engine on all the fuels was achieved after various precautions had been taken and troubles overcome. These included standardising on a detergent lubricating oil, evolving a fuel system in which the pre-heat temperature was maintained constant at all points, decarbonising the injection nozzles at weekly intervals, and replacing the austenitic steel exhaust valves by Brightray-coated silicon-chromium valves. The consequences of burning cheap fuels were found to be a higher rate of cylinder wear and more frequent routine maintenance, but the trials proved conclusively that the regular use of such fuels was both practicable and economic.

A serious problem met in the earlier tests was the rapid corrosion of the exhaust-valve seating faces. This took the form of "wire-drawing" or "guttering" followed by gas blow-by and severe burning of the valve over an arc of about 1½ in., as shown above. Standard valves made from En 54 heat-resisting austenitic steel were burnt out in 50 hours or less. The trouble was evidently due to the corrosive action of the fuel-ash deposits which gradually build up on the exhaust valves when non-distillate fuels are used. Most residual oils contain a small proportion of vanadium in their ash content and it is therefore likely that vanadium pentoxide is formed during the combustion process; this particular compound has frequently demonstrated in gas turbines and steam superheaters its extremely corrosive nature at high-temperatures.

Among the various attempts made to extend valve life was the experimental use of a set of En54 valves coated on the seating face with Brightray nickel-chromium alloy, a product of Henry Wiggin and Company, Limited, Wiggin-street, Birmingham, 16. It was found that the Brightray-coating was able to resist corrosion throughout long periods of continuous service. The coating proved so effective that the valve material was subsequently changed to En 52 silicon-chromium steel, which proved to have the necessary strength at high temperature for this application. The Mirrlees Company has recently decided to standardise on coated valves for all K-class power units. Users will thus be able to convert to heavy-oil burning without modifying any of the internal parts of their engines.

The Brightray alloy is supplied in the form of wire and applied to the valve seat by means of an oxy-acetylene welding process, after primary machining operations have been performed on the valves. Following Brightray deposition, the valves are fully heat treated and finally machined to extremely close tolerances. On the basis of the experience so far gained with K-class engines burning boiler oil, it appears necessary to lift the exhaust valves for cleaning and re-seating every 500 hours or so. If this is not done, the accumulation of deposits will prevent the valve from functioning correctly and will hamper engine performance. There is no difficulty in cleaning the valves, the alloy being hard enough for a scraper to be used without damaging the coating.

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PLASTICS EXHIBITION AND CONVENTION

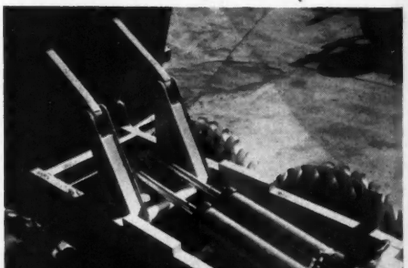
The complete programme of the Convention to be held in conjunction with the British Plastics Exhibition at Olympia, London, W.14, from June 1 to 11, has now been published. The morning and afternoon sessions on Thursday, June 2, will deal with "Polymer Structures and Properties"; that on Friday morning, June 3, with "Expanded Plastics" and that in the afternoon of June 3 with "Thermoplastics." "Extrusion" will be the subject discussed on Monday morning, June 6, and "Works Study" will be dealt with on Monday afternoon. The whole of Tuesday, June 7, will be devoted to "Injection Moulding," and "Patents" will be discussed on Wednesday morning, June 8, and "Foundry Resins" in the afternoon. The final day of the convention, Thursday, June 9, will be given up to discussions on "Glass-Reinforced Plastics." (See page 386.)

HEAVY-DUTY TIPPING GEAR FOR VEHICLES

High-Speed Action by Hydraulic Cylinders and Link Mechanisms

The heavy-duty vehicle tipping gear introduced by Telehoist Limited, Swindon-lane, Cheltenham, has been specially designed for use on heavy, six-wheeled, short-wheelbase vehicles, and gives a particularly fast tip, with an angle sufficient to dump from a scow-ended body. The tipping gear is a self-contained unit carried in a fabricated steel sub-frame mounted on the vehicle chassis.

At the inner, or driver's cab end of the sub-frame there are pivoted two single-stroke, double-acting hydraulic cylinders, of 6½ in. bore. The bores are honed to a fine finish, and the piston rods are plated for wear-resistance. All the bearings are of bronze and, with the hydraulic seals, are easily replaceable in case of wear. The ends of the piston rods are coupled to a cross-member which forms part of a pair of bell-crank levers pivoted to the sub-frame on the chassis. The long arms of the bell-cranks are in turn coupled to thrust links hinged to the sub-frame of the vehicle body. In operation the bell-cranks provide a mechanical leverage which multiplies the movement of the hydraulic pistons. The result is a rapid movement of the vehicle body to its extreme tipping position while the hydraulic pistons travel through a relatively short distance. Consequently it is possible to use cylinders of reasonable size, which lie almost flat, and enable the centre of gravity of the load to be lowered. It is also possible to use a hydraulic pump of relatively small volumetric capacity, which takes up a negligible amount of room on the vehicle. The hydraulic cylinders work at a mechanical disadvantage as a result of increasing the leverage to give a high rate of tipping, but they are rated, together with the pump, in excess



High speed of operation is achieved by bell-crank levers and links coupled to twin hydraulic cylinders.

The Telehoist tipping gear will tip a body with a pay load of 18 tons to an angle of 70 deg. in 12 seconds.

of the normal working load, and are never loaded to capacity.

The gear-type hydraulic pump is mouned on the chassis and driven through a power take-off from the vehicle engine. The pump has a maximum capacity of 32 gallons per minute, and draws its oil from a 19-gallon reservoir which can be fixed in any convenient position on the chassis, either on the side or between the frame members, according to the space available. A filter and safety-valve are provided on the oil reservoir. Control of the hydraulic system is by means of a piston valve, mounted near to the reservoir, and having an extension-rod into the cab, where it can be operated by the driver. The valve has three positions; raise, hold and circulate, and lower.

At a recent demonstration the tipping gear was shown fitted to a Thorneycroft "Big Ben" six-wheeled vehicle, as illustrated opposite. The gear tipped a gross load of 21½ tons (including the body weight of 3½ tons) in 12 seconds to an angle of 70 deg. and returned the body in 10 seconds. The angle of tip can be 50 deg. or 70 deg., according to the type of vehicle and body to which it is fitted.

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TOWN GAS FROM PETROLEUM

The South Eastern Gas Board and the British Petroleum Company, Limited, have agreed jointly to examine the practicability of building a plant to convert petroleum products available at the company's Kent oil refinery, Isle of Grain, north-east of Chatham, to town gas of acceptable quality. The gas would be fed into the Board's gas-grid system near Strood. This grid system, which is being rapidly developed, will serve the whole of South London and extend to Guildford in the West, Horsham in the south, and Rochester and Maidstone in the east. It will cover an area of 1,750 square miles and serve four million persons.

THE SEGAS PROCESS

The Board have developed a catalytic oil gasification process capable of using a wide range of products from butane to heavy fuel oil and of producing town gas efficiently from this range of products. The Segas process was discovered in the Board's central laboratories in the Old Kent-road and a prototype installation, designed jointly with the Power Gas Corporation Limited, who became licensees for the plant, has been erected at the Bell Green Gasworks, Lower Sydenham, where it is producing up to 800,000 cub. ft. a day of gas of standard quality. It may be recalled that an illustrated description of this plant appeared in our issue of January 8, 1954, on pages 34 and 52. Briefly the gas is produced as the result of the reaction between superheated steam and vaporised fuel oil in the presence of a lime and magnesite catalyst.

The process gives great flexibility which can be exercised to considerable advantage when the gasification plant is situated in or adjacent to a large-scale oil refinery. This ensures the regular supply of the petroleum products needed.

MAXIMUM ANNUAL SAVING OF COAL, 700,000 TONS

The proposal, therefore, is that the installation should be situated at and operated in conjunction with the Isle of Grain Kent oil refinery. The Board would thus join with the British Petroleum Company to utilise their combined technical experience in gas manufacture and the cracking of petroleum products in a manner which would facilitate the discharge by the Board of their statutory obligations.

The initial installation would convert some 50,000 tons of petroleum products a year to gas and would have a daily output of 15 million cub. ft. of gas. It would be arranged for extension to a capacity of from 40 to 45 million cub. ft. daily with an annual petroleum usage of up to 150,000 tons. If the scheme goes forward to the maximum scale contemplated, the saving in coal would amount to about 700,000 tons annually.

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NEW TITLES FOR NAVAL RATINGS

Elimination of Term "Stoker"

New titles for ratings in the engineering and electrical branches of the Royal Navy have been approved by Her Majesty the Queen, and take effect from March 17, 1955. The accompanying list shows the new titles and their shortened forms. Electrical branch ratings in the Fleet Air Arm will be re-named similarly. The reason for the changes is that the Board of Admiralty have formed the opinion that the present title of ratings in the engine-room branch, and to a lesser degree in the electrical branch, can easily give, to persons unfamiliar with naval tradition and with recent shipboard developments, a wrong impression of the duties those branches perform. The term "Stoker" is no longer used because coal-fired boilers have been eliminated from the Fleet and survive only in a few trawlers employed on in-shore tasks. Moreover, it is considered that the titles are a real, if minor, contributory cause of present recruiting difficulties in the branches concerned.

Old titles	New titles	New short titles
Engineering Mechanic Branch:		
Junior Stoker	Junior Engineering Mechanic	J.M.(E)
Stoker	Engineering Mechanic 2nd Class	M.(E) II
Stoker Mechanic	Engineering Mechanic 1st Class	M.(E) I
Leading Stoker Mechanic	Leading Engineering Mechanic	L.M.(E)
Petty Officer Stoker Mechanic	Petty Officer Engineering Mechanic	P.O.M.(E)
Chief Petty Officer Stoker Mechanic	Chief Engineering Mechanic	Ch.M.(E)
Electrical Branch:		
Junior Electrician's Mate	Junior Electrical Mechanic	J.E.M.
Junior Radio Electrician's Mate	Junior Radio Electrical Mechanic	J.R.E.M.
Electrician's Mate 2nd Class	Electrical Mechanic 2nd Class	E.M.II
Radio Electrician's Mate 2nd Class	Radio Electrical Mechanic 2nd Class	R.E.M.II
Electrician's Mate 1st Class	Electrical Mechanic 1st Class	E.M.I.
Radio Electrician's Mate 1st Class	Radio Electrical Mechanic 1st Class	R.E.M.I
Leading Electrician's Mate	Leading Electrical Mechanic	L.E.M.
Leading Radio Electrician's Mate	Leading Radio Electrical Mechanic	L.R.E.M.
Electrician	Petty Officer Electrician	P.O.El.
Radio Electrician	Petty Officer Radio Electrician	P.O.R.El.

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KOTRI BARRAGE OPENED

Irrigation Scheme in Pakistan

The Kotri Barrage, in the Sind province of Pakistan was opened on March 15 by the Governor-General, Mr. Ghulam Mohammed. The ceremony marked the completion of Pakistan's greatest irrigation project since partition and one of the major irrigation works of the world.

The main barrage spanning the River Indus is approximately 3,000 ft. long and contains 43 sluice gates each of 60 ft. span, 21 ft. deep and weighing 45 tons; the barrage gates, together with the canal head sluice gates, lock gates and a lift bridge as well as their supporting structures and operating gear were made by Ransomes and Rapier Limited, Ipswich, Suffolk, who were also responsible for their erection at site. The maximum flood discharge will be about 875,000 cusecs and will be used to irrigate about 2¾ million acres. Water from feeder canals on the right bank will be used to form a lake 20 miles long and 45 square miles in extent; this will form a reservoir for the water supply of Karachi and afford facilities for the production of hydro-electric power.

A road bridge 20 ft. wide with two 4-ft. footpaths has been provided across the barrage and, as noted in our issue of February 11, is believed to be the longest prestressed-concrete bridge in Asia; it was constructed by the British firm of Gammon (Pakistan) Limited, who have their London offices at 16 Caxton-street, Westminster. Two fish ladders have been incorporated in the barrage to enable the valuable palla fish to move up-stream without difficulty. The cost of the entire scheme has been estimated to be Rs. 250 million.

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PORTABLE GAS TURBINE

Used as Auxiliary Power Plant in Aircraft

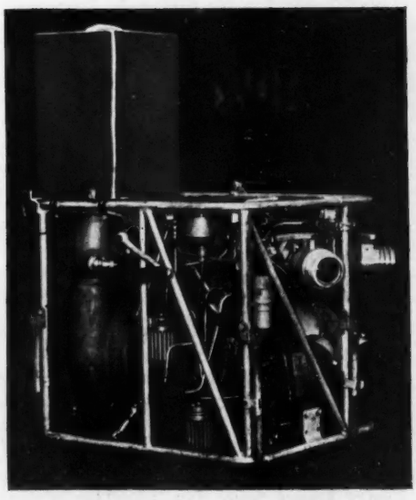
As stated in a Weekly Survey note, a power unit of American design known as the "Mars" gas turbine is to be made in this country. This small portable plant develops 60 h.p., runs on a variety of fuels, and has applications as a prime mover extending from power generating to pumping. The turbine, which has also been widely used in the United States as an auxiliary power plant in aircraft, is shown in the accompanying illustration, which gives some indication of its size.

The basic engine, including speed reducing gears, weighs less than 100 lb. and is smaller than a two-foot cube. It operates at a speed of approximately 40,000 revolutions per minute and will run on natural gas, Diesel oil, jet-engine fuel or high-octane petrol. It can be started electrically or by hand, and may be used as an airborne power unit, a ground unit for starting jet-aircraft engines, a prime mover for generators, or a power source for electronic equipment. It is also suitable for use with marine, fire-fighting, or compressed-air pumps.

Mars auxiliary power units installed in Douglas Globemaster transport aircraft have completed over 22,000 hours service without trouble and are fitted in the military version of the Lockheed Super Constellation. Recently the normal electrical supply of a four-engined aircraft failed when it was two hours out over the sea in dangerous icing conditions. The small gas turbine was brought into action and met all electrical demands for instruments, lighting, radio, de-icing, undercarriage and flaps until the aircraft landed safely.

The Mars gas turbine is made by the Solar Aircraft Company, San Diego, California, U.S.A., and is to be built in this country by Sugg Solar, Limited, a subsidiary of William Sugg and Company, Limited, Regency-street, London, S.W.1.

(*Editorial Comment in Weekly Survey*)



The American "Mars" gas turbine, which is to be made in this country, weighs 100 lb. and can develop 60 horse-power. Its applications include pumping and generating.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list appears in the last issue of each month. Events appearing for the first time, and alterations of dates, place, etc., are indicated by an asterisk (*). Particulars of forthcoming exhibitions and conferences not included below may have appeared in ENGINEERING, *February 25, page 254. Organisers are invited to send to the Editor particulars of forthcoming events as soon as arrangements are made.*

*PLASTICS EXHIBITION.—Mon., Mar. 28, to Sat., April 2, at 95 New-street, Birmingham. Organised by Bakelite Ltd., 12 to 18 Grosvenor-gardens, London, S.W.1. Tel. SLOane 0898.

MILAN INTERNATIONAL SAMPLES FAIR.—Tues., April 12, to Wed., April 27. *Agent:* Dr. V. Schiazzano, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

LYONS INTERNATIONAL TRADE FAIR.—Sat., April 16, to Mon., April 25. *Agents:* Robert Brandon and Partners, Ltd., 47 Albemarle-street, London, W.1. Tel. HYDe Park 0901.

SWISS INDUSTRIES FAIR.—Sat., April 16, to Tues., April 26, at Basle, Switzerland. Apply to the Swiss Legation, 18 Montague-place, Bryanston-square, London, W.1. Tel. PADdington 0701.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—*Diamond Jubilee, Spring Meeting:* Mon., April 18, to Thurs., April 21, at Baltimore. *Instruments and Regulators Conference:* Mon. and Tues., April 25 and 26, at Ann Arbor, Mich. Apply to the American Society of Mechanical Engineers, 29 West 39th-street, New York, 18.

*BUSINESS EFFICIENCY EXHIBITION.—Tues., April 19, to Fri., April 22, at the City Hall, Hull. Organised by the Office Appliance and Business Equipment Trades Association, 11–13 Dowgate-hill, London, E.C.4. Tel. CENtral 7771.

LIÉGE INTERNATIONAL TRADE FAIR.—Sat., April 23, to Sun., May 8, at Liége. Organised by the Foire Internationale de Liége, 17 Boulevard d'Avroy, Liége, Belgium. *Agents:* Mattis Industries, Ltd., 252 Abbey House, Victoria-street, London, S.W.1. Tel. ABBey 7571.

*LILLE INTERNATIONAL FAIR.—Sat., April 23, to Sun., May 8, at Lille. Apply to the administration offices, Grand Palais, Lille (Nord), France. See ENGINEERING, March 11, page 321.

BRUSSELS INTERNATIONAL TRADE FAIR.—Sat., April 23, to Sun., May 8, at the Palais du Centenaire, Brussels. Apply to the organisers at that address.

IRON AND STEEL ENGINEERS, ASSOCIATION OF (AMERICAN).—*Spring Conference:* Mon., April 25, to Wed., April 27, at Detroit. *Annual Convention:* Mon., Sept. 26, to Thurs., Sept. 29, at Chicago. Apply to Association of Iron and Steel Engineers, Empire Building, Pittsburg 22, Pa., U.S.A.

PHYSICAL SOCIETY'S EXHIBITION OF SCIENTIFIC INSTRUMENTS AND APPARATUS (39TH).—Mon., April 25, to Thurs., April 28, at the Royal Horticultural Hall, Vincent-square, London, S.W.1. Organised by the Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. Tel. KENsington 0048. See ENGINEERING, November 5, 1954, page 595.

*RAILWAY TRACTION CONFERENCE (INTERNATIONAL).—Mon., April 25, to Thurs., April 28, at Liége. Organised by the Association des Ingénieurs Sortis de l'Ecole de Liége, 22 Rue Forgeur, Liége.

*HEALTH CONGRESS.—Tues., April 26, to Fri., April 29, at Bournemouth. Organised by the Royal Sanitary Institute, 90 Buckingham Palace-road, London, S.W.1. Tel. SLOane 5134. See ENGINEERING, March 11, page 321.

*MANAGING SMALL FIRMS (CONFERENCE).—Fri. and Sat., April 29 and 30, at Harrogate. Apply to the British Institute of Management, 8 Hill-street, London, W.1. Tel. GROsvenor 6000. See ENGINEERING, March 11, page 321.

BRITISH INDUSTRIES FAIR.—Mon., May 2, to Fri., May 13, at Olympia, London, W.14; and Castle Bromwich, Birmingham. Particulars from British Industries Fair Ltd., Ingersoll House, 9 Kingsway, London, W.C.2. Tel. COVent Garden 1461; or from the general manager, British Industries Fair, 95 New-street, Birmingham, 2. Tel. Midland 5021.

DUBLIN SPRING SHOW AND INDUSTRIES FAIR.—Tues., May 3, to Sat., May 7, at Ballsbridge, Dublin. Apply to the Royal Dublin Society, Ballsbridge, Dublin.

NORTHERN RADIO SHOW.—Wed., May 4, to Sat., May 14, at the City Hall, Manchester. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

PHOTOGRAPHY AND CINEMA EXHIBITION.—Wed., May 4, to Mon., May 16, in Paris. Organised by the Biennale Internationale de la Photographie et du Cinéma, 116 bis Avenue des Champs-Élysées, Paris.

GERMAN HANDICRAFTS AND TRADE FAIR.—Fri., May 6, to Sun., May 15, at Munich. Organised by the Verein für Handwerks-Ausstellungen und Messen e.V., Theresienhöhe 14, Munich 12, Germany.

ELECTRIC HEATING CONFERENCE.—Tues. and Wed., May 10 and 11, at Chicago, Ill., U.S.A. Apply to American Institute of Electrical Engineers, 33 West 39th-street, New York 18.

ACHEMA XI GERMAN CHEMICAL APPARATUS CONGRESS AND EXHIBITION.—Sat., May 14, to Sun., May 22, at Frankfurt-on-Main. Organised by DECHEMA Deutsche Gesellschaft für chemisches Apparatewesen, Rheingau-Allee 25, Frankfurt-on-Main.

PARIS TRADE FAIR (44TH).—Sat., May 14, to Mon., May 30. *Agent:* Mrs. M. Hyde-Joucla, 14 Rugby Chambers, Rugby-street, London, W.C.1. Tel. CHAncery 6794.

NEW YORK TRADE FAIR.—Sun., May 15, to Thurs., May 19, at the Armory, 25th-street, Manhattan, New York. Organised by International Trade Shows, 545 Fifth-avenue, New York.

INTERNAL COMBUSTION ENGINE CONGRESS, INTERNATIONAL.—"COLLOQUY 1955—THE HAGUE."—Mon., May 23, to Sat., May 28, at Scheveningen, Holland. Organised by the Congrès International des Moteurs à Combustion Interne, 11 Avenue Hoche, Paris, 8e. Inquiries in Britain may be sent to the secretary of the British National Committee, c/o The British Internal Combustion Engine Manufacturers' Association, 6 Grafton-street, London, W.1. Tel. HYDe Park 5107. See ENGINEERING, September 24, 1954, page 389.

MEDITERRANEAN FAIR (TENTH).—Wed., May 25, to Fri., June 10, at Palermo. Organised by Fiera del Mediterrano, Piazza Generale Cascino, Palermo.

PADUA INTERNATIONAL FAIR AND PACKAGING SALON.—Sun., May 29, to Mon., June 13, at Padua. Organised by Fiera di Padova, 59 Via N. Tommaseo, Padua, Italy.

CANADIAN INTERNATIONAL TRADE FAIR (EIGHTH).—Mon., May 30, to Fri., June 10, at Toronto. Further information from Miss M. A. Armstrong, Canadian Government Exhibition Commission, Canada House, Trafalgar-square, London, S.W.1. Tel. WHItehall 8701.

*LARGE DAMS (FIFTH CONGRESS OF THE INTERNATIONAL COMMISSION).—Tues., May 31, to Sat., June 4, in Paris. Apply to the British National Committee, 201–202 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966. See ENGINEERING, April 2, 1954, page 448; October 22, 1954, page 520; and Mar. 4., page 262.

BATH AND WEST AGRICULTURAL SHOW.—Wed., June 1, to Sat., June 4, at Launceston, Cornwall. Organised by the Bath and West and Southern Counties Society, 3 Pierrepont-street, Bath. Tel. Bath 3010.

BRITISH PLASTICS EXHIBITION.—Wed., June 1, to Sat., June 11, at Olympia, London, W.14. Organised by "British Plastics" Dorset House, Stamford-street, London, S.E.1. Tel. WATerloo 3333. (See page 384.)

*CENTENARY OF ALUMINIUM EXHIBITION.—Wed., June 1, to Sat., June 11, at the Royal Festival Hall, London, S.E.1. Organised by the Aluminium Development Association, 33 Grosvenor-street, London, W.1. Tel. MAYfair 7501. See ENGINEERING, February 11, page 164.

WORLD PETROLEUM CONGRESS.—Mon., June 6, to Wed., June 15, in Rome. Apply to the British National Committee, 26 Portland-place, London, W.1. Tel. LANgham 2250.

BUSINESS EFFICIENCY EXHIBITION.—Mon., June 6, to Thurs., June 16, at Olympia, London, W.14. Organised by the Office Appliance and Business Equipment Trades Association, 11-13 Dowgate-hill, London, E.C.4. Tel. CENtral 7771.

BUILDING PLANT EXHIBITION.—Wed., June 8, to Wed., June 15, at the Queenslie Industrial Estate, Glasgow. Organised by the Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611. See ENGINEERING, December 10, 1954, page 773.

*WELDING TECHNICIANS' ANNUAL CONGRESS.—Mon., June 13, to Thurs., June 16, at Frankfurt-on-Main. Organised by the German Welding Society, Harkortstrasse 27, Düsseldorf.

CONFERENCE ON COMBUSTION.—Wed., Thurs. and Fri., June 15, 16 and 17, at Cambridge, Mass., U.S.A. Organised by the American Society of Mechanical Engineers, 29 West 39th-street, New York, 18; and Tues., Wed. and Thurs., Oct. 25, 26 and 27, in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476. See ENGINEERING, September 24, 1954, page 398.

CONFERENCE ON AUTOMATIC FACTORIES.—Thurs., June 16, to Sun., June 19, at Margate. Organised by the Institution of Production Engineers, 10 Chesterfield-street, London, W.1. Tel. GROsvenor 5254. See ENGINEERING, November 26, 1954, page 683.

NON-DESTRUCTIVE TESTING CONGRESS.—Wed., June 22, to Sat., June 25, at the Royal Technical College, Glasgow. Summer Meeting, Non-Destructive Testing Group, Institute of Physics, 47 Belgrave-square, London, S.W.1. Tel. SLOane 9806.

SAFETY AND FACTORY EFFICIENCY EXHIBITION.—Fri., June 24, to Fri., July 1, at Bingley Hall, Birmingham. Information from the Industrial Safety Training Centre, Museum of Science and Industry, Newhall-street, Birmingham, 3.

*BRITISH ELECTRICAL POWER CONVENTION.—Mon., June 27, to Fri., July 1. Meetings at The Dome, Brighton; exhibition at the Sports Stadium, West-street, Brighton. Organised by the British Electrical Development Association, 2 Savoy-hill, London, W.C.2. Tel. TEMple Bar 9434.

MACHINE TOOL EXHIBITION.—Mon., July 4, to Sat., July 9, at Sydney. Apply to the Sydney Chamber of Commerce, 36 Grosvenor-street, Sydney.

PRINTING, MACHINERY AND ALLIED TRADES EXHIBITION (IPEX).—Tues., July 5, to Sat., July 16, at Olympia, London, W.14. Promoted by the Association of British Manufacturers of Printers' Machinery (Proprietary) Ltd., Clifford's Inn, London, E.C.4. Organisers: F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 0568.

*NATURALLY-OCCURRING NITROGEN HETEROCYCLIC COMPOUNDS, SYMPOSIUM ON.—WED., July 13, to Fri., July 15, at the University College of the South West of England, Exeter. Organised by the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675. Apply to Dr. K. Schofield, Washington-Singer Laboratories, Prince of Wales-road, Exeter.

*WATER SUPPLY CONGRESS AND EXHIBITION (INTERNATIONAL).—Mon., July 18, to Sat., July 23, at Royal Horticultural Society's Halls, Vincent-square, London, S.W.1. Organised by the International Water Supply Association, 34 Park-street, London, W.1. Tel. GROsvenor 1092. See ENGINEERING, March 11, page 304.

AUTOMOTIVE ENGINEERS, SOCIETY OF.—*West Coast Meeting:* Mon., Aug. 15, to Wed., Aug. 17, at Portland, Oregon. *Aircraft Production Forum and Aircraft Engineering Display:* Tues., Oct. 11, to Sat., Oct. 15, at Los Angeles. *Transportation Meeting:* Mon., Oct. 31, to Wed., Nov. 2, at St. Louis, Miss. *Diesel Engine Meeting:* Wed., Nov. 2, to Fri., Nov. 4. Apply to the Society of Automotive Engineers, 29 West 39th-street, New York, 18.

*GAS SALES AND SERVICE CONFERENCE (FOURTH).—Mon., Sept. 12, to Wed., Sept. 14., at the Heads of Ayr Holiday Camp, Ayr, Scotland. Organised by the Gas Council, 1 Grosvenor-place, London, S.W.1. Tel. SLOane 4554. (Alteration of dates).

*ELECTROMAGNETICALLY-ENRICHED ISOTOPES (CONFERENCE).—Tues., Sept. 13, to Fri., Sept. 16, at the Atomic Energy Research Establishment, Harwell, Berks. Tel. Abingdon 620. See ENGINEERING, March 11, page 321.

BUILDING EXHIBITION (26TH).—Wed., Nov. 16, to Wed., Nov. 30, at Olympia, London, W.14. Apply to the Building Trades Exhibition, 4 Vernon-place, London, W.C.1. Tel. CHAncery 2223.

*LESS COMMON METALS, SYMPOSIUM ON.—Thurs., and Fri., Mar. 22 and 23, 1956, in London. Organised by the Institution of Mining and Metallurgy, Salisbury House, Finsbury-circus, London, E.C.2. Tel. NATional 0621. (Alteration of dates.)

Labour Notes

EQUAL PAY IN ENGINEERING

Difficulties respecting the introduction of equal pay into the engineering group of industries were referred to by Mr. Robert Openshaw, the President of the Amalgamated Engineering Union, in his introductory address at the annual conference of the union's women delegates at Torquay on March 16.

There could be no doubt, Mr. Openshaw affirmed, that women had entered these industries to stay and it would be as well if that position were generally recognised. It was a fact to which the union had directed the attention of employers on many occasions.

Managements must cease to regard women merely as temporary workpeople and must reorganise not only their thinking but also their factories, in order that women might be given their rightful place in industrial life: alongside the men operatives.

Although it was never stated in so many words, employers as a whole did not regard women as capable of performing the same work as men and that made the task of achieving equal pay between the two sexes a difficult one.

GIRLS AS APPRENTICES

There were grave shortages of skilled craftsmen throughout the engineering industries and there seemed to be no reason why women could not fill the gaps. With this end in view, Mr. Openshaw said, the union was trying to implement a policy of apprenticeships for girls. The suggestion had been laid before the employers' organisation and a reply was now being awaited.

It was pointed out, on behalf of the union's executive council, that the differential between the present basic rate for women and that for adult men labourers had been raised by the recent wage increases from £1 7*s.* 8*d.* to £1 15*s.* 8*d.* a week.

Women with up to 15 years' experience in engineering works obtained employment on the basis of that experience and yet there were men, who might never previously have seen the inside of an engineering workshop, getting £1 15*s.* 8*d.* a week more than they were, simply to sweep floors. It was important, therefore, that the union should keep drawing the attention not only of employers, but also of its own members, men and women, to the size of the differentiation.

The delegates passed unanimously a resolution re-affirming the declaration of a previous conference that " the existing schedule of women's rates is a standing disgrace to the whole trade-union movement and especially to the engineering industry." The union's executive committee was requested to continue to press for the minimum rate for women to be brought up to the level of the basic rate paid to adult male labourers.

RAILWAY PRODUCTIVITY COUNCIL

The three railway unions and the Confederation of Shipbuilding and Engineering Unions have agreed in principle to suggestions by the British Transport Commission that a new organisation should be set up to promote efficiency and productivity on the railways.

Mr. Harold Watkinson, Parliamentary Secretary to the Ministry of Labour, gave this information in answer to a parliamentary question on March 15, and stated that the new body would be known as the British Railways Productivity Council. The Confederation was invited to assist in the matter on account of the large number of employees in railway workshops who are affiliated to that organisation.

The latest proposals are the culmination of a number of efforts which have been made by the management of British Railways during recent years to secure the active co-operation of the unions, at various levels, in securing improvements in output and efficiency. There appears to be good reason for hoping that, in this instance, a much larger measure of success will attend the joint endeavours now to be made by the two sides.

There have been various signs lately of the adoption of a much more realistic attitude by the railway unions.

Special significance in this connection is attached to the assurance which Mr. J. S. Campbell, the general secretary of the National Union of Railwaymen, gave at the recent court of inquiry into the railway-wage dispute, that he would use his whole influence to obtain the willing co-operation of members of his union in the carrying out of improvements.

A preliminary meeting between leading officials of the unions and representatives of the British Transport Commission took place in London, on March 17, to discuss the functions and procedure of the new Council.

MINERS' NEW WAGE STRUCTURE

A fundamental re-organisation of the wage structure in the coal-mining industry was agreed to between the National Coal Board and the National Union of Mineworkers on March 15.

The new arrangements provide for increases of 11*s.* 6*d.* a week on the present minimum basic rates for day-wage men, whether employed on the surface or underground, as from April 4 next. There will also be increases of at least 6*s.* a week for most of the 380,000 to 400,000 miners engaged at time rates.

These changes will mean a new minimum rate of £7 6*s.* 6*d.* a week, for miners employed on the surface, and of £8 6*s.* 6*d.* a week, for men working underground. It is hoped that an extension to the new wage structure, applicable to piece workers and similar employees, will be negotiated during the next few months. Most of these men are engaged on work at the coalface.

The new agreement is the result of several years of effort to arrange a new wage structure for the industry. A major part of the task, only recently completed, was the drawing up of some 350 descriptions to cover the thousands of jobs performed by miners at collieries and mining workshops throughout the country. In many cases, the same work had been differently designated at different collieries in the same district.

These 350 jobs, as classified, were then arranged according to importance in five underground grades, five surface grades, and six craftsmen's grades. The concluding stage was the negotiation of the wage rates to be paid to the employees in each grade.

It is estimated that the cost to the Board will amount to £13,200,000 a year.

FEWER ANOMALIES

The Board and the union confidently expect that the new rates will produce greater uniformity in the payment made for corresponding work in different districts. They hope that the wage structure in the industry has now been placed on a juster and more equitable basis, and that many anomalies have at last been removed.

The new standard rates range from £1 4*s.* 5*d.* to £1 11*s.* 1*d.* a shift for the five grades of surface workers, and from £1 7*s.* 9*d.* to £1 11*s.* 9*d.* for the five grades of underground employees. The difference between each grade, other than the winding enginemen, who form the highest-paid surface grade, is one shilling a shift.

In the case of the craftsmen, the three surface grades will receive rates varying from £1 7*s.* 1*d.* to £1 12*s.* 1*d.* a shift; and the three underground grades rates varying from £1 10*s.* 5*d.* to £1 15*s.* 5*d.* a shift. These grades will be spaced at 2*s.* 6*d.* a shift in each group. As miners who work five shifts in any week are paid for six, the basic weekly wage rates for the three underground craftsmen's grades will be £9 2*s.* 6*d.*, £9 17*s.* 6*d.* and £10 12*s.* 6*d.*, respectively.

It is a feature of the agreement that no one will suffer a reduction in pay as a result of the introduction of the new wage structure and that, as far as possible, all miners will obtain some increase.

Some anomalies will remain as, in a few cases, men doing the same work will be paid at different rates, and men carrying out different tasks will be paid at the same rates. Such cases, however, will rarely arise in the same colliery or even in the same locality.

The agreement was accepted by a large majority at a delegate conference called by the union last Friday and the proposals are now being submitted to a ballot in the coalfields, the results of which will be known by the union on Wednesday next.

NON-INDUSTRIAL CONDITIONS

The text of a private member's Bill, aimed at improving working conditions in non-industrial establishments, was published on March 15. It is sponsored by a Labour Member of Parliament, Mr. Harold Davies, and is intended to implement the recommendations of the Gowers Committee in relation to working conditions among non-industrial employees.

The Bill is one of considerable complexity. It contains three schedules defining the conditions of work which will be required to be maintained if it becomes law. Lighting, temperature and ventilation standards are laid down, and other demands include the amount of space needed for each employee and the number of " sanitary conveniences " for different sizes of staff.

In shops and offices, a temperature of at least 65 deg. F. would require to be provided, as well as a minimum space of 400 cub. ft. for every person regularly employed in a confined space.

MANY IMPROVEMENTS SOUGHT

The Gowers Committee was set up in 1946 to investigate working conditions in non-industrial establishments and to study the health, safety and welfare of persons employed therein. Its report was completed in 1949, but no Government legislation has been brought forward to give effect to its recommendations.

Mr. Davies estimates that more than twelve million persons in Britain, employed in offices, shops, cinemas, and similar places, and in agriculture, are unprotected by legislation regarding their safety and working conditions. These persons are those whose places of employment are not covered by the Mines and Quarries Act or the Factories Act.

In the main, the Bill follows the recommendations of the Gowers Committee, but provides for greater improvements in cases where better conditions have already been secured by private agreements between employers and the unions.

The Home Secretary has stated that he feels that the subject is not suitable for a private member's Bill, although the Government is fully in sympathy with the aims of the present Bill. A further statement is expected on April 1, when the Bill is given a second reading.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

BRISTOL
Open Meeting. Bristol and West of England Branch. Grand Hotel, Bristol. Fri., April 1, 8 p.m.

British Institution of Radio Engineers

LONDON
Discussion on "The Maintainability of Services Equipment," opened by Captain (L) A. J. B. Naish, Major R. B. Brenchley, Wing Commander G. C. Godfrey and G. W. A. Dummer. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., Mar. 30, 6.30 p.m.

MANCHESTER
"Electronic Control of Industrial Production Processes," by J. A. Sargrove. Annual General Meeting. North-Western Section. College of Technology, Sackville-street, Manchester. Thurs., Mar. 31, 7 p.m.

TREFOREST
"Electronics in Industry," by M. N. Lapper. South Wales Section. Glamorgan Technical College, Treforest. Wed., Mar. 30, 6.30 p.m.

Chemical Society

LONDON
Symposium on "Peptide Chemistry." Royal Institution, Albemarle-street, W.1. Wed., Mar. 30, 10.30 a.m. and 2.30 p.m.
"The Outlook for Industrial Atomic Energy in Europe," by Dr. G. Randers. Royal Institution, Albemarle-street, W.1. Thurs., Mar. 31, 11 a.m.

Illuminating Engineering Society

LONDON
Discussion on "Home Lighting." E.L.M.A. Lighting Service Bureau, 2 Savoy-hill, Strand, W.C.2. Tues., Mar. 29, 6 p.m.

LEEDS
Annual General Meeting and Film Evening. Leeds Centre. E.L.M.A. Lighting Service Bureau, 24 Aire-street, Leeds, 1. Mon., Mar. 28, 6.15 p.m.

LEICESTER
"The Use of X-Rays in Medicine and Industry," by J. E. Hood and G. Whiteley. Leicester Centre. Offices of the East Midlands Electricity Board, Charles-street, Leicester. Mon., Mar. 28, 6 p.m.

Incorporated Plant Engineers

CARDIFF
Annual General Meeting. South Wales Branch. Grand Hotel, Cardiff. Thurs., Mar. 31, 7.15 p.m.

LEEDS
Annual General Meeting. West and East Yorkshire Branch. The University, Leeds. Mon., Mar. 28, 7.30 p.m.

LEICESTER
Annual General Meeting. Leicester Branch. Bell Hotel, Humberstone Gate, Leicester. Wed., Mar. 30, 6.30 p.m.

Institute of British Foundrymen

LONDON
"Safety in the Foundry," by A. Talbot. London Branch. Waldorf Hotel, Aldwych, W.C.2. Wed., Mar. 30, 7.30 p.m.

BRADFORD
"Sand for Floor Moulding," by W. B. Parkes. West Riding of Yorkshire Branch. Technical College, Bradford. Wed., Mar. 30, 6.30 p.m.

NEWCASTLE-UPON-TYNE
"Exothermic Feeding Heads," by W. Stewart. Annual General Meeting. Newcastle Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Sat., April 2, 6 p.m.

SHEFFIELD
"Foundry Safety: Some Effects of Changing Legislation," by R. F. Ottignon. College of Technology, Pond-street, Sheffield. Mon., Mar. 28, 7.15 p.m.

THORNABY-ON-TEES
Annual General Meeting and Open Discussion. Tees-Side Branch. Head, Wrightson & Co., Ltd., Teesdale Hall, Thornaby-on-Tees. Fri., April 1, 7.30 p.m.

Institute of Fuel

CARDIFF
"The Start of the National Industrial Fuel Efficiency Service," by Dr. W. A. Macfarlane. South Wales Section. South Wales Institute of Engineers, Park-place, Cardiff. Fri., April 1, 6 p.m.

GLASGOW
Open Meeting. Scottish Section. Royal Technical College, Glasgow. Fri., April 1, 7 p.m.

MIDDLESBROUGH
"Producer Gas," by Dr. G. D. Milner. North-Eastern Section. Cleveland Scientific and Technical Institute, Corporation-road, Middlesbrough. Mon., Mar. 28, 6.30 p.m.

Institute of Marine Engineers

LONDON
"The U.S.S. Timmerman: An Advanced Design Destroyer," by Commander D. G. Phillips, U.S.N. Tues., Mar. 29, 5.30 p.m.

BATH
"Some Factors in the Selection of Machinery for Cargo Liners," by L. Baker. West of England Section. Offices of Smith Brothers, Westgate Buildings, Bath. Mon., Mar. 28, 7 p.m.

Institute of Metals

OXFORD
Discussion on "Non-Destructive Testing," opened by Dr. E. G. Stanford. Annual General Meeting. Oxford Local Section. Cadena Café, Cornmarket-street, Oxford. Tues., Mar. 29, 7 p.m.

Institute of Refrigeration

LONDON
Symposium of papers on "Modern Trends in the Storage of Fruit and Vegetables," by W. H. Smith, Dr. W. G. Burton and Dr. J. C. Fidler. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Mar. 31, 5.30 p.m.

Institution of British Agricultural Engineers

LONDON
"Technical Developments in the Lubrication of Tractors," by E. S. Bates. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., Mar. 29, 2.15 p.m.

Institution of Civil Engineers

LONDON
"The Extension of the Runway at the Royal Naval Air Station, Belfast," by L. R. Greenaway and J. Callagin. Airport Engineering Division. Tues., Mar. 29, 5.30 p.m.
"Hydraulic Aspects of Sewerage and Sewage Disposal," by C. B. Townend and G. W. Wilkinson. Hydraulics Engineering Division. Tues., April 5, 5.30 p.m.

Institution of Electrical Engineers

LONDON
"An Introduction to the Transistor," by A. V. Bryant. London Students' Section. Mon., Mar. 28, 6.30 p.m.
"Electrical Energy from the Wind," by E. W. Golding. Thurs., Mar. 31, 5.30 p.m.
"High-Speed Electronic-Analogue Computing Techniques," by Dr. D. M. MacKay. Joint Meeting of the Measurements and Radio Sections. Tues., April 5, 5.30 p.m.

BIRMINGHAM
"The Recent Search for, and Salvage of, the Comet Aircraft near Elba," by Commander C. G. Forsberg and G. G. MacNeice. South Midland Radio Group. James Watt Memorial Institute, Great Charles-street, Birmingham. Mon., Mar. 28, 6 p.m.

CARDIFF
"The Navigator and His Instruments," by W. L. S. Harrison. Western Utilization Group. South Wales Institute of Engineers, Park-place, Cardiff. Mon., Mar. 28, 6 p.m.

GLASGOW
"Aluminium Sheathed Cables," by P. M. Hollingsworth and P. A. Raine. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow. Wed., April 6, 7 p.m.

HULL
"Some Design Features of the Semi-Outdoor Power Station at Ince," by F. H. S. Brown. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Thurs., Mar. 31, 7.15 p.m.

LIVERPOOL
"Special Effects for Television Studio Productions," by A. M. Spooner and T. Worswick. Annual General Meeting. Mersey and North Wales Centre. Royal Institution, Colquitt-street, Liverpool. Mon., April 4, 6.30 p.m.

MANCHESTER
"Electrical Energy from the Wind," by E. W. Golding. North-Western Centre. Engineers' Club, Albert-square, Manchester. Tues., April 5, 6.15 p.m.

NEWCASTLE-UPON-TYNE
"The Standardisation of Retail Electricity Tariffs," by A. O. Johnson and N. F. Marsh. North-Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Mar. 28, 6.15 p.m.

NOTTINGHAM
"The Economics of Low-Voltage Electricity Supplies to New Housing Estates," by F. G. Copland. East Midland Centre. Offices of the East Midlands Gas Board, Nottingham. Tues., Mar. 29, 6.30 p.m.

WEYMOUTH
"Cold Cathode Valves," by J. R. Acton. Southern Centre. South Dorset Technical College, Weymouth. Fri., April 1, 6.30 p.m.

YORK
"Possibilities of a Cross-Channel Power Link Between the British and French Supply Systems," by D. P. Sayers, M. E. Laborde and F. J. Lane. North Midland Centre. Station Hotel, York. Tues., April 5, 7 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
Films on "Diesel Engines and Aeronautics." North-East Branch. Northern Architectural Association, 6 Higham-place, Newcastle-upon-Tyne. Thurs., April 7, 7.15 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
"The Prevention of Smoke from Heating Boilers," by T. F. Hurley and L. J. Flaws. Scottish Branch. Scottish Building Centre, 425 Sauchiehall-street, Glasgow, C.2. Tues., Mar. 25, 7 p.m.

LEICESTER
Annual General Meeting. East Midlands Branch. Grand Hotel, Leicester. Wed., April 6, 6.30 p.m.

Institution of Highway Engineers

LONDON
Discussion on "The Present Road Programme," to be opened by C. T. Brunner, Lieut.-Colonel A. C. Newman and Sir Owen E. Williams. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Fri., April 1, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Special meeting for consideration of new draft by-laws. Tues., Mar. 29, 5.30 p.m.
"An Electrolytic Tank Investigation into Stepped Thrust Bearings," by Dr. C. F. Kettleborough; "Journal Bearing Performance under Sinusoidally Alternating and Fluctuating Loads," by Dr. G. S. A. Shawki and B. Freeman; "Bending Stresses in Spur Gear Teeth—Proposed New Design Factors Based on a Photoelastic Investigation," by M. A. Jacobson; "Prediction and Measurement of Vibration in Marine Geared Shaft Systems," by the late H. G. Yates; "The Promotion of Fluid Lubrication in Wire Drawing," by Professor D. G. Christopherson and H. Naylor; and "Experimental Investigation of the Mechanics of Wire Drawing," by J. G. Wistreich. Applied Mechanics Group. Fri., April 1, 2 p.m.
"Matching a Diesel Engine to Light Road Vehicles," by N. Vulliamy; "Some Aspects of the Design and Performance of Small Diesel Engines," by B. W. Millington and M. H. Howarth; and "Fuel Requirements of the Small Automotive High-Speed Diesel Engine," by G. M. Barrett and H. G. Freeston. Automobile Division. Tues., April 5, 5.30 p.m.

DERBY
"Nuclear Reactors and Power Production," by Sir Christopher Hinton. Derby A.D. Centre. Welfare Hall, Rolls-Royce Ltd., Derby. Mon., Mar. 28, 7 p.m.

DONCASTER
"The Application of Shock-Absorbers and Buffers," by A. P. FitzJohn. Yorkshire Branch. Mansion House, Doncaster. Wed., Mar. 30, 7 p.m.

FARNBOROUGH
"Tracer-Controlled Machine Tools," by H. C. Town. Southern Branch. Royal Aircraft Establishment Technical College, Farnborough. Wed., Mar. 30, 7.30 p.m.

GLOUCESTER
"Aspects of the Design and Performance of Small Diesel Engines," by B. W. Millington and M. H. Howarth. Western A.D. Centre. Technical College, Gloucester. Thurs., Mar. 31, 7.15 p.m.

GRIMSBY
"Inspection, Explosion and Breakdown of Boilers and Pressure Vessels," by J. Eyers. East Midlands Branch. Royal Hotel, Grimsby. Wed., Mar. 30, 7.30 p.m.

RUGBY
Thomas Lowe Gray Lecture on "Some Factors in the Selection of Machinery for Cargo Liners," by Commander L. Baker. Midland Branch. College of Technology and Arts, Rugby. Tues., Mar. 29, 6.30 p.m.

Institution of Production Engineers

CAMBORNE
"History and Practice of Metal Perforating," by H. M. Sawyer. Camborne Section. School of Mines, Camborne, Cornwall. Thurs., Mar. 31, 7.15 p.m.

CARDIFF
"Economics in Production Engineering," by Dr. F. A. Wells. South Wales and Monmouthshire Section. South Wales Institute of Engineers, Park-place, Cardiff. Thurs., Mar. 31, 7 p.m.

LUTON
"Management and Production," by H. Bainbridge. Luton Section. Town Hall, Luton. Tues., Mar. 29, 7.15 p.m.

SHREWSBURY
Annual General Meeting and Film Evening. Shrewsbury Section. Technical College, Shrewsbury. Wed., Mar. 30, 6.45 p.m.

Institution of the Rubber Industry

LEICESTER
Annual General Meeting and Film Evening. Leicester Section. Bell Hotel, Leicester. Thurs., Mar. 31, 7.30 p.m.

MANCHESTER
"Application of Rubber to Fibres," by Dr. T. S. McRoberts and C. D. Hogg. Manchester Section. Engineers' Club, Albert-square, Manchester. Mon., Mar. 28, 6.45 p.m.

Institution of Sanitary Engineers

LONDON
"Sanitary Engineering: Sundry Impressions," by G. Lloyd Ackers. Caxton Hall, Westminster, S.W.1. Wed., Mar. 30, 6 p.m. (Alteration of date.)

Junior Institution of Engineers

LONDON
Film Evening. Fri., April 1, 7 p.m.

Royal Aeronautical Society

LONDON
"Application of Aerial Survey to the Economic Development of a Country," by T. D. Weatherhead. Thurs., Mar. 31, 7 p.m.

Royal Society of Arts

LONDON
"Mechanical Properties of Metals. III—Fatigue," by Major P. L. Teed. Mon., Mar. 28, 6 p.m.
"Recent Developments in Deep-Sea Diving," by Sir Robert H. Davis. Wed., Mar. 30, 2.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Mechanism of the Action of Boron in Low-Alloy Steels," by F. B. Pickering. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield. Tues., Mar. 29, 7 p.m.

Society of Chemical Industry

LONDON
"Attention to Corrosion in the U.S.A.," by F. L. Laque. Church House, Great Smith-street, S.W.1. Wed., Mar. 30, 6.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. (SLOane 6233.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institution of British Agricultural Engineers, 24 Portland-place, London, W.1. (LANgham 3394.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria-street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 12 Whitehall, London, S.W.1. (WHItehall 5012.)
Institution of Sanitary Engineers, 118 Victoria-street, London, S.W.1. (VICtoria 3017.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield 7. (Sheffield 53674.)
Society of Chemical Industry, 56 Victoria-street, London, S.W.1. (VICtoria 5215.)